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UNIVERSITY OF TORONTO

CALENDAR



Faculty of Applied Science
and Engineering

1965-1966

UNIVERSITY OF TORONTO PRESS
1965

CALENDAR 1965

Jan.

S	M	T	W	T	F	S
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CALENDAR 1966

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June

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July

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Aug.

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Sept.

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Nov.

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Dec.

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SECTION I. CALENDAR 1965–66

FALL TERM, 1965

July 1	*Thursday*	Dominion Day. Buildings closed.
August 2	*Monday*	Civic Holiday. Buildings closed.
August 16	*Monday*	Students of the III Year, Course 1, report at Survey Camp.
August 23	*Monday*	Students of the III Year, Courses 2 and 9, and IV Year, Course 1, Option B, report at Survey Camp.
September 6	*Monday*	Labour Day. Buildings closed.
September 8	*Wednesday*	Fall Examinations commence.
		Students in II Year, Course 6, report for Analytical Chemistry Laboratory.
September 16	*Thursday*	Registration in person of the I Year from 9:30 a.m. to 12 noon and from 2 p.m. to 4:30 p.m. in the Galbraith Building.
		Meeting of Faculty Council.
September 17	*Friday*	Registration in person of the II Year from 9:30 a.m. to 12 noon and of the III Year from 2 p.m. to 4:30 p.m. in the Galbraith Building.
		Dean's address to the I Year at 9 a.m. in Convocation Hall.
		Preliminary instruction to the I Year.
September 18	*Saturday*	Registration in person of the IV Year from 9:30 a.m. to 12 noon in the Galbraith Building.
September 20	*Monday*	Lectures and laboratory work commence at 9 a.m.
		Opening address by the President to the students of all Faculties at 4:15 p.m. in Convocation Hall. Lectures and laboratory classes withdrawn from 4 p.m.
October 5	*Tuesday*	Meeting of Faculty Council.
October 8	*Friday*	Meeting of Senate.
October 11	*Monday*	Thanksgiving Day. Buildings closed.
November 3	*Wednesday*	Meeting of Faculty Council.
November 11	*Thursday*	Remembrance Day Service 10:45 a.m. Lectures and laboratory classes withdrawn from 10 a.m. to 12 noon.
November 12	*Friday*	Meeting of Senate.
November 26	*Friday*	Fall Convocation.
December 2	*Thursday*	Meeting of Faculty Council.
December 10	*Friday*	Meeting of Senate.

December 17	*Friday*	Term ends at 5 p.m.
December 25	*Saturday*	Christmas Day. Buildings closed.

SPRING TERM, 1966

January 1	*Saturday*	New Year's Day. Buildings closed.
January 3	*Monday*	Spring term begins. Mid-session Examinations commence.
January 10	*Monday*	Meeting of Faculty Council.
January 14	*Friday*	Meeting of Senate.
January 15	*Saturday*	Last day for receiving the second term instalment of fees.
January 20	*Thursday*	IV Year Employment interviews.
January 21	*Friday*	IV Year Employment interviews.
January 22	*Saturday*	IV Year Employment interviews.
February 2	*Wednesday*	Meeting of Faculty Council.
February 11	*Friday*	Meeting of Senate.
March 1	*Tuesday*	Meeting of Faculty Council.
March 11	*Friday*	Meeting of Senate.
April 1	*Friday*	Meeting of Faculty Council.
April 7	*Thursday*	Term ends at 5 p.m. Meeting of Senate.
April 8	*Friday*	Good Friday. Buildings closed.
April 18	*Monday*	Annual Examinations commence.
May 4	*Wednesday*	Meeting of Faculty Council.
May 13	*Friday*	Meeting of Senate.
May 23	*Monday*	Victoria Day. Buildings closed.
May 30 to June 10	*Monday* to *Friday*	University Convocations.

SECTION II. ADMINISTRATIVE OFFICERS

ADMINISTRATIVE STAFF

1964–1965

THE UNIVERSITY

President . . . C. T. Bissell, M.A., Ph.D., D.Litt., LL.D., F.R.S.C.
Vice-President (Academic) . . . M. St. A. Woodside, M.A., LL.D.
Principal of Scarborough College and Vice-President for Scarborough and Erindale Colleges . D. C. Williams, M.A., Ph.D.
Executive Assistant to the President . . . . . J. H. Sword, M.A.
Presidential Advisor on Research Policy . . . G. de B. Robinson, M.B.E., B.A., Ph.D., F.R.S.C.

Registrar . . . . . R. Ross, M.B.E., M.A.
Chief Librarian . . . . . R. H. Blackburn, M.A., B.L.S., M.S.
Director of University Extension . . . . . G. H. Boyes, M.A.

Vice-President (Administration) . . . . F. R. Stone, B.Com., C.A.
Comptroller . . . . . G. L. Court, D.F.C., M.Com., C.A.
Secretary of the Board of Governors . . . . . D. S. Claringbold
Superintendent of Buildings and Grounds . F. J. Hastie, B.Sc., P.Eng.
Chief Accountant . . . . . D. J. Reid

Director of the University of Toronto Press . . . M. Jeanneret, B.A.

Director of Alumni Affairs . . . . . J. C. Evans, B.A.
Director of Information . . . . . K. S. Edey
Director of Development . . . . . R. J. Albrant
Director of Graduate Records . . . . . C. G. M. Grier, E.D., M.A.

Warden of Hart House . . . . . J. McCulley, M.A.
Director of University Health Service G. E. Wodehouse, M.C., M.D., F.R.C.P.
Assistant Director of University Health Service—Women . . . . . Miss F. H. Stewart, B.A., M.D.
Director of the Placement and Housing Services . . . . . J. K. Bradford, O.B.E., M.A.Sc.
Director of Athletics and Physical Education—Men . W. A. Stevens, B.S.
Director of Athletics and Physical Education—Women . Miss Z. Slack, B.A.
Administrator, Students' Administrative Council . R. S. Rawlings, B.A.
Director of Hart House Theatre . . . . . R. S. Gill, M.A.

THE FACULTY OF APPLIED SCIENCE AND ENGINEERING

Dean . . . . . R. R. McLaughlin, M.A.Sc., M.A., PH.D.
Assistant Dean and Secretary . . . . . J. A. Gow, B.A.Sc.
Assistant Secretary . . . . . W. H. Sisson, B.A.Sc.

SECTION III. TEACHING STAFF

1964–65

PROFESSORES EMERITI

E. A. Allcut, M.Sc. (Birm.), M.E., F.R.Ae.S., 315 Lawrence Ave. W.
Professor Emeritus of Mechanical Engineering

E. G. R. Ardagh, B.A.Sc., F.C.I.C., F.R.S.C. 219 Old Yonge St.
Professor Emeritus of Chemical Engineering

W. B. Dunbar, B.A.Sc. 241 Glebeholme Blvd.
Professor Emeritus of Engineering Drawing

K. B. Jackson, B.A.Sc., D.Sc. (Waterloo) 362 Glengrove Ave.
Professor Emeritus of Applied Physics

T. R. Loudon, V.D., B.A.Sc., C.E., Hon. F.C.A.I., Hon. M.E.I.C. 189 Sheldrake Blvd.
Professor Emeritus of Civil and Aeronautical Engineering

W. G. McIntosh, B.A.Sc. 101 Park Ave., Newmarket
Professor Emeritus of Mechanical Engineering

J. W. Melson, B.A.Sc. 69 Walmsley Blvd.
Professor Emeritus of Surveying and Geodesy

E. A. Smith, M.A. (McM.) Gormley
Professor Emeritus of Chemical Engineering

G. F. Tracy, B.A.Sc., S.M. (M.I.T.) 153 Strathallan Blvd.
Professor Emeritus of Electrical Engineering

A. Wardell, B.A.Sc. 124 Melrose Ave.
Professor Emeritus of Engineering Drawing

W. J. T. Wright, M.B.E., B.A.Sc., B.A. 126 Melrose Ave.
Professor Emeritus of Engineering Drawing

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

Professor and Head of the Department

J. G. Breckenridge, B.A.Sc., Ph.D. (Cantab.) 23 Douglas Cres.

Professors

W. F. Graydon, M.A.Sc., Ph.D. (Minn.) North Drive, R.R.1, Islington
W. G. MacElhinney, M.A.Sc. 1459 Stavebank Rd., Port Credit
R. R. McLaughlin, M.A.Sc., M.A., Ph.D. 102 Glen Rd.
W. H. Rapson, M.A.Sc., Ph.D. 53 Pine Cres.
M. Wayman, M.A., Ph.D. 17 Noel Ave.

Professor of Nuclear Engineering

D. G. Andrews, M.A. (Cantab.) 1459 Shamrock Lane, Oakville

Associate Professors

D. Basmadjian, Dip.Ing.Chem. (Zurich), M.A.Sc., Ph.D. Wallberg Bldg.
W. H. Burgess, B.Ch.E., M.F.S., Ph.D. (Corn.) 57 Ridley Blvd.
R. L. Hummel, B.S. (Purdue), Ph.D. (Iowa) Apt. 6, 68 Kendal Ave.

R. E. Jervis, M.A., PH.D. — 21 High Hill Dr., Agincourt
R. W. Missen, M.SC.(QU.), PH.D.(CANTAB.) — 648 Broadway Ave.
S. Sandler, M.A.SC. — 5 Evanston Dr., Downsview
I. H. Spinner, M.A.SC., PH.D. — 28 Sealcove Dr., Etobicoke
O. Trass, B.S.E.(PRINC.), SC.D.(M.I.T.) — Apt. 409, 206 St. George St.

Assistant Professors

M. E. Charles, B.SC.(LOND.), M.SC., PH.D.(ALTA.) — 7 Carlis Place, Port Credit
R. Luus, M.A.SC., PH.D.(PRINCETON) — Wallberg Bldg.
J. W. Smith, M.A.SC.(U.B.C.), PH.D.(LOND.) — 33 Airdree Rd.

Lecturers

C. C. Barnes, B.SC.(QU.) — 107 King St. E.
J. Binkiewicz, DIP.CHEM.ENG.(LWOW) — 38 Nina St.
Z. May, DIP.ING.CHEM.(WARSAW) — 29 Linden St.
Miss M. J. Phillips, B.A.SC., M.A.(BRYN MAWR), PH.D.(J.H.U.) — 123 Glengrove Ave.
A. Rozieu, DIP.ING.(BUCHAREST) — Apt. 3, 14 Markdale Ave.

Special Lecturers

C. P. Brockett, B.SC.(M.I.T.) — 60 Crescent Rd.
H. D. Sharma, M.SC.(DELHI), PH.D.(CAL.) — 20 Meadowbrook Rd.

Instructor

J. Sowa (MRS.), B.SC.(DAL.), M.A.SC. — 31 Alexander St., Apt. 415

Demonstrators

D. G. Atkins, B.A.SC. — 23 Freeborn Cres.
R. Berezowsky, B.A.SC. — 67 Garden Ave.
K. Biron, B.A.SC. — 590 Spadina Ave.
D. A. Dawson, B.SC.(QU.) — 1735 Victoria Pk. Ave. Apt. 204
E. J. Dewar, B.SC.(MT. ALL.), B.E.(N.ST.C.) — Apt. 705, Massey House, 108 Isabella St.
W. J. Dowkes, B.A.SC. — 11 Roxborough St. West
R. J. Fleming, B.A.SC. — 135 Rose Ave., Apt. 1402
J. D. Ford, B.ENG.(MCG.), N.A.SC. — 121 Southill Dr., Don Mills
O. Figueiredo, B.SC., M.SC.(BOMBAY) — 536 Huron St.
B. I. Friedlander, B.A.SC., M.A.SC. — 30 Fraserwood Ave.
C. C. Gryte, B.A.SC. — 14 Paulson Rd.
L. H. Gevaert, B.A.SC. — Apt. 216, 166 Wilson Ave.
H. Goodfellow, B.A.SC. — 135 Rose Ave., Apt. 1402
R. A. Gowen, B.A.SC.(U.B.C.) — 550 Jarvis St., Apt. 1110
D. S. Holland, B.ENG.(MCM.) — 95 Tudedo Ave. S., Hamilton
J. J. Henley, B.ENG.(N.S.TECH.) — 634 Bathurst St.
F. Ho, B.A.SC. — 34 Sussex Ave.
C. C. Hong, B.S.(NAT. TAIWAN), M.A.SC.(U.B.C.) — 160 Beverley St.
R. F. Hunter, B.A.SC., M.A.SC. — 143 Douglas Ave.
W. J. Jackson, B.A.SC. — 50 Harbord St.
E. E. Jokipii, B.A.SC. — R.R.2, Hornby, Ont.
I. Krizancic, B.A.SC. — 174 Dundas St. W., Cooksville

J. R. Millar, b.a.sc. 65 Broadway Ave.
S. Nargolwalla, b.sc.(punjab), m.a.sc. 2803 Bathurst St.
S. P. T. O'Neill, b.a.sc. 3464 Yonge St., Apt. 15
N. K. Patni, b.ch.e.(bombay), m.s.(wash. state) 39 Walmer Rd.
A. T. Popovich, chem.eng.(zagreb), m.a.sc. 88 Homewood Ave.
S. R. Rao, m.sc.(calcutta), m.a.sc. 39 Walmer Rd.
V. V. Rao, b.chem.eng.(bombay), m.a.sc. 39 Walmer Rd.
E. J. Ryan, m.sc.(u.n.b.) 319 Monarch Park Ave.
P. J. Simmons, b.a.sc. 1114 Glengrove Ave. W.
Y. Y. Spolsky, b.a.sc. 88 Concord Ave.
K. S. (Henry) Tan, b.s.ch.e.(m.i.t., manilla) 65 Sussex St.
J. Torok, b.a.sc., m.a.sc. 92 Farnham Ave.
T. M. Tuszynski, b.a.sc. 424 Euclid Ave.
B. O. Wasmund, m.sc.(qu.) 2433 Finch Ave. W.
R. H. Weiland, b.a.sc. 10 McNairn Ave.
K. Y. Wong, b.a.sc. 70 Sussex Ave.
R. K. Young, b.a.sc., m.a.sc. 1654 Bathurst St.
T. J. Varkey, b.sc., m.a., b.sc., m.a.(madras) 32 Sussex St.
G. Zone, b.a.sc. 3894 Bathurst St., Apt. 207

DEPARTMENT OF CIVIL ENGINEERING

Professor and Head of the Department

C. F. Morrison, b.e.(sask.), m.sc.(mcg.) 21 Douglas Cres.

Professors

M. W. Huggins, m.a.sc. 531 Windermere Ave.
G. Kani, dr.ing.(stuttgart) 57 Castle Frank Cres.
O. J. Marshall, b.a.sc., c.e., o.l.s. 48 Haddington Ave.

Associate Professors

J. D. Barber, m.a.sc. 7 Wythenshawe Wood, Scar.
R. A. Collins, b.a.sc., m.s.(ill.), ph.d.(ill.) 44 Chatsworth Dr.
A. C. Davidson, b.sc., c.e., b.sc., e.e.(man.), m.a.sc. 106 Bideford St., Downsview
M. M. Davis, b.sc.(qu.), m.sc.(purdue) 112 Three Valleys Dr., Don Mills
F. A. De Lory, b.eng.(mcg.), m.a.sc., d.i.c.(imp.), ph.d.(lond.) 34 Farnham Ave.
H. R. Frizzle, b.sc., e.e.(n.s. tech.) 268 Kingsdale Ave., Willowdale
B. J. Haynes, b.a.sc., o.l.s. 8 Dervock Cres., Willowdale
C. E. Helwig, m.a.sc. 89 Woodlawn Ave. W.
C. Hershfield, b.sc.(man.), m.a.sc. 3 Windmill Rd.
D. J. L. Kennedy, b.a.sc., m.s.(ill.), ph.d.(ill.) 18 Hatherton Cres., Don Mills
H. L. Macklin, b.a.sc., o.l.s., d.l.s. 29 Blyth Hill Rd.
J. Schwaighofer, dip.ing.(graz.), m.s.(penn. st.), ph.d.(penn. st.) 268 Poplar Plains Rd.
C. A. Wrenshall, b.e.(sask.) 358 Spring Garden Ave., Willowdale

Assistant Professors

A. P. Bernhart, dipl.ing.(graz.), dr.tech.(graz.) 23 Cheritan Ave.
C. W. Dillane, b.a.sc. Kemptville
R. C. Gunn, m.a.sc. 251 Lytton Blvd.
K. Meipoom, m.a.sc. 24 Farnham Ave.
E. I. Robinsky, b.a.(beirut), b.sc.(beirut), m.s.(harvard), ph.d. 301 Jedburgh Rd.
K. A. Selby, b.a.sc., m.b.a. 23 The Palisades
R. M. Soberman, b.sc.(dalh.), s.m.(m.i.t.), ph.d.(m.i.t.) Apt. 414, 650 Eglinton Ave. W.
S. M. Uzumeri, m.a.sc. 253 Berry Rd.
J. Vlcek, b.sc.f.(n.b.), m.a.sc. 15 Talwood Dr., Don Mills

Lecturers

S. J. G. Bird, m.a.sc., o.l.s. 281 St. Clements Ave.
V. P. Borecky, dipl.ing.(prague), m.a. 265 Ellis Ave.
G. W. Heinke, m.a.sc. 129 Beaver Bend Cresc., Islington
E. Karuks, m.a.sc. 35 Burgess Ave.
J. Timusk, m.a.sc. (On leave of absence for the session)
R. G. Tress, b.a.sc. 2082 Dickson Rd., Cooksville
G. T. Will, m.a.sc. 41 Ridley Blvd.
P. Wodzianski, mgr.ph.(warsaw) 11 Park Home Ave., Willowdale

Special Lecturer

M. G. Tallon, b.a.sc. 80 Chelford Rd., Don Mills

Instructors

S. L. Grenzebach, b.a.sc. 198 Leonards Ave.
G. R. West, b.a.sc.(elect.) 29 Glenholme Ave.
G. H. Wilkes, b.a.sc. 2330 Sheppard Ave. W. Weston

Part-time Instructors

N. K. Agarwal, b.sc.(engg.)(birla) 71 Brunswick Ave.
R. H. Amaral, b.a.(laurentian), b.a.sc. 435 Lauder Ave.
G. J. K. Asmis, b.a.sc. 27 Irwin St.
M. Z. Beg, b.sc.(engg.)(punjab) 124 Baldwin St.
R. Bertram, b.a.sc.(chem.) 31 Alexander St., City Park Apts., Apt. 211
F. Cico, dip.ing.(zagreb) 490 Eglinton Ave. E.
S. Divakaran, b.e.(civil)(andrha) 200 Beverley St.
H. T. Donaldson, b.a.(queens) 149 Glenwood Cres.
R. G. Drysdale, b.sc.(man.) 111 Lawton Blvd., Apt. 502
H. W. Duncan, b.e.(n.s.t.c.) 287 Heath St. E.
C. Fung, b.eng.(mcgill) 24 Summerhill Gdns.
E. H. Geissler, dipl.eng.(hanover) 10 Dunboyne Court, Willowdale
E. Gharghoury, dipl.eng., ecole nat., des ponts et chau. 1969 Eglinton Ave. W.
J. Gilbert, b.a.sc. 125 Hillcrest Ave., Willowdale
B. J. Goodal, b.a.sc., m.s.(ill.) 3 Meridith Cres.
J. MacD. Hall, b.a.sc., m.a.sc. 70 King St., Weston

R. E. Howard, B.A.Sc. 14 Handel St.
F. W. Jung, Dipl.Ing.(Tech.Hoch.Darmst.), M.A.Sc. 8 Duggan Ave.
F. Keenan, B.A.Sc. 730 Ontario St., Apt. 1414
S. Khalifa, M.E.(Aust.N.S.W.) 45 Major St.
P R. Kluchert, B.A.Sc.(Wat.) 41 Hillsboro, Apt. 6
J. D. Law, B.Sc.(Queen's) 25 Bridesburg, Apt. 501
J. C. S. Lee, B.A.(Taiwan) 231 Beverley St.
A. W. McMullen, B.A.Sc. 24 Barbara Cres.
R. A. McNally, B.A.Sc. 66 Spadina Rd., Apt. 101
V. Ma, B.A.E.(Nat.Sw.Assoc. China) 550 Spadina Ave.
H. F. Microys, B.A.Sc. 8 St. Thomas St., Apt. 42
H. R. Miron, B.A.Sc. 221 St. George St.
E. N. Onen, Y.Muh.For.(Istan.), B.S., C.E.(Columb), M.S.(Columb.) 61 Grenoble Dr., Suite 5
J. H. L. Palmer, B.A.Sc. 76 Gormley Ave.
J. G. Pike, B.A.Sc. 71 Cranborne Ave.
Z. Przygoda, M.Sc.(Danzg.), D.Sc.(Tech.Un.Mun.) 25 Ashgrove Place, Don Mills
W. F. Purvis, B.A.Sc. 211 Glen Road
A. A. Rose, B.A.Sc. 20 Whitelock Cres., Willowdale
M. T. Shetty, B.A.(Madras), B.E.(Madras) 374 Huron St.
M. D. Stewart, B.A.Sc. 122 Bedford Rd.
D. C. K. Tay, B.Sc.Eng.(London), M.A.Sc. 700 Ontario St., Apt. 1205
M. Thompson, B.A.Sc. 4 Devonshire Pl.
M. P. Whelen, M.A.Sc.(Elect.) 575 Avenue Rd., Apt. 501

DEPARTMENT OF ELECTRICAL ENGINEERING

Professor and Head of the Department

J. M. Ham, B.A.Sc., S.M., Sc.D.(M.I.T.) 135 Glencairn Ave.

Assistant Professor and Assistant Head of the Department

W. Janischewskyj, B.A.Sc., M.A.Sc. 65 Humbercrest Blvd.

Professors

N. F. Moody, B.Sc.(Sask.) 44 Coldstream Ave.
Director of Institute of Biomedical Electronics

G. K. M. Pfestorf, Dr.(Jena), (Visiting Professor)
Director of Schering Institute Technical University, Hannover, W. Germany

J. E. Reid, B.A.Sc. 152 Donegal Dr.
G. Sinclair, B.Sc.(Alta.), M.Sc.(Alta.), Ph.D.(Ohio State) 62 Felbrigg Ave.
G. R. Slemon, M.A.Sc., D.I.C.(Imp.Coll.), Ph.D.(Lond.) 40 Chatfield Dr., Don Mills
V. G. Smith, B.A.Sc. 142 Dawlish Ave.

Associate Professors

P. P. Biringer, Dip.Ing.(Bud), M.Sc.(Stockholm), Ph.D. 6 Lumley Ave.

P. E. Burke, B.E.(N.S.TECH.), M.A.SC. 1 Terrington Court, Don Mills
V. L. Henderson, B.A.SC., A.M.(MICH.) 397 Glengrove Ave. W.
A. J. Kravetz, B.SC.(ALTA.), M.A.SC. 500 Riverside Dr.
G. R. Lang, B.SC.(U.W.O.) 30 Guiness Ave., Rexdale
A. Straughen, B.SC.(LOND.), M.A.SC. 25 Maxwell Ave.
J. L. Yen, B.SC.(CHIAO TUNG), M.A.SC., PH.D. 20 Swiftdale Place, Don Mills

Assistant Professors

J. R. Bird, B.A., M.A., PH.D. 52 Gilgorm Rd.
H. A. Courtice, B.A.SC. 166 Parkview Hill Cres.
Miss M. G. Currie, B.A.SC. 89 Broadway Ave.
I. R. Dalton, B.A.SC., M.S.(NORTHWEST) 20 Wilgar Rd.
E. J. Davison, A.R.C.T., B.A.SC., M.A., PH.D.(CANTAB) 9 Cortland Ave.
S. Dmitrevsky, M.A.SC., A.M.(HARVARD) 11 Dervock Cresc., Willowdale
W. Janischewskyj, B.A.SC., M.A.SC. 65 Humbercrest Blvd.
I. McCausland, B.SC.(Q.U.BELFAST), M.SC.(Q.U.BELFAST), PH.D.(CANTAB) 5 Devonshire Pl.

Special Lecturer

G. F. Tracy, B.A.SC., S.M.(M.I.T.) 153 Strathallan Blvd.

Professor Emeritus of Electrical Engineering

Lecturers

R. T. H. Alden, B.A.SC., M.A.SC. (part-time) Massey College
D. E. Chambers, B.SC.(Q.U.BELFAST), PH.D.(Q.U.BELFAST) 20 Classic Ave., New College
J. A. Field, B.E.(SASK.), M.A.SC. 33 Riverwood Pkwy.
E. S. Lee, B.ENG.(MCG.), M.ENG.(MCG.) 15 Westridge Rd., Islington
F. G. Mason, B.E.(N.S.TECH.), M.A.SC. 100 Gloucester St.
N. C. McDermott, B.A.SC. 87 Reynolds St. S., Oakville
S. D. T. Robertson, B.SC.(QUEEN'S), D.I.C.(IMP.COLL.), M.A.SC. 60 Madison Ave.
B. F. Smith, B.A.SC. 29 Stansbury Cres., Scarborough

Instructors

H. D. Gorakhpurwalla, B.SC.(BOMBAY), B.S.E.E.(PURDUE), M.S.E.E.(PURDUE) 10 Kings Point Dr.
Mrs. S. Mosher, E.E.(ODESSA), M.A.SC. 4 Mascot Place, Willowdale

Demonstrators (part-time)

M. Albisser, B.ENG.(MCG.) 14 Prince Arthur Ave.
J. W. Atwood, B.ENG.(MCG.) 37 Lowther Ave.
K. L. Bhatnagar, B.SC.(DELHI), D.I.I.SC.(BANGALORE) 200 Beverley St.
J. B. Billingsley, B.A.SC. 700 Ontario St.
O. Z. Bluy, B.A.SC. 23 Westmount Ave.
P. I. P. Boulton, B.A.SC., M.A.SC. 14 Westchester Ave.
L. D. Braun, B.A.SC., M.A.SC. 86 Bedford Rd.
R. Chouinard, B.A.SC.(LAVAL) 559 Davisville Ave.
M. A. Copeland, B.SC.(MAN.), M.A.SC. 81 MacLean Ave.
S. B. Dewan, B.SC., M.E.(ROORKEE) Massey College

C. K. Duff, B.A.Sc.	8 Strathearn Blvd.
R. D. Findlay, B.A.Sc.	12 Pell St., Scarborough
C. Flacks, B.A.Sc.	4866 Bathurst St., Willowdale
J. W. Goodanetz, B.A.Sc.	143 Gillard Ave.
K. G. Goyal, B.Sc.(Rajputana), M.Sc.(Jaipur), M.Sc.(Birla)	181 College St.
G. G. H. Gray, B.A.Sc.	45 Old Park Rd.
J. D. A. Griffin, B.A.Sc.	18 Bracondale Hill Rd.
M. A. K. Hamid, B.Eng.(McG.), M.Eng.(McG.)	54 Harbord St.
J. G. Heller, B.A.Sc., M.A.Sc.	65 Nealon Ave.
H. P. Homonick, B.A.Sc.	3308 Dundas St. West
F. Juranka, B.A.Sc.(Budapest)	93 Ellsworth St.
J. P. Knight, B.Sc.(Queen's), M.A.Sc.	37 Cavendish St.
J. D. Lavers, B.Sc.(Dalhousie)	Massey College
G. G. McKye, B.A.Sc.	379 Huron St.
D. M. Monro, B.A.Sc.	166 Carlton St.
B. Mons, B.A.Sc.	26 Shangarry Dr.
M. S. Narashima, B.Sc., B.E., M.E.(Bangalore)	191 Beverley St.
P. V. Ozawa, B.A.Sc.	354 Spadina Rd.
Kundur Prabhashankar, B.E.(Mysore), M.E.(Bangalore)	392½ Markham St.
A. O. Quanbury, B.Sc.(Queen's)	17 Boswell Ave.
V. S. Rajamani, B.E.(Madras), M.A.Sc.	181 College St.
Azizur Rahman, B.Sc.(Dacca)	26½ Glasgow St.
M. Ramamoorty, B.Eng.(Andhra), M.E.(Bangalore)	37 Major St.
F. V. Robinson, B.Sc.(Sask.)	157 Keewatin Ave.
M. P. Sarma, B.E.(Andhra), M.E.(Bangalore)	69 Baldwin St.
P. C. Sen, B.Sc., M.Sc.(Calcutta)	227 Beverley St.
Chia-Hsin Shih, B.Sc.(Taiwan)	76 Henry St.
A. C. Stevenson, B.A.Sc.	317 Walmer Rd.
M. J. Stewart, B.A.Sc.	1108A Yonge St.
D. R. Studney, B.A.Sc.	19 Pricefield Rd.
A. L. Van Koughnett, B.E.Sc.(Western), M.A.Sc.	227 Cosburn Ave.
J. V. Wall, B.Sc.(Queen's)	88 Bernard Ave.
P. V. Wanek, B.S.E.E.(Wisconsin)	55 Elm Ave.
G. L. Yip, B.Sc.(London), M.Sc.(Queen's)	153 Rusholme Rd.
J. W. Zaleski, B.A.Sc.	197 College St.
S. Zelin, B.A.Sc., M.A.	249 Winnett Ave.

DEPARTMENT OF ENGINEERING SCIENCE

Head of the Department

V. G. Smith, B.A.Sc. — 142 Dawlish Ave.
Professor of Electrical Engineering

Members of the Department

B. Etkin, M.A.Sc., F.C.A.S.I. — 8 Bitterroot Rd.
Professor of Aeronautics and Astronautics

W. F. Graydon, M.A.Sc., Ph.D.(Minn.) — North Drive, R.R. 1, Islington
Professor of Chemical Engineering

T. E. Hull, M.A., Ph.D. — 26 George Henry Blvd., Willowdale
Professor of Mathematics

G. D. Scott, M.A., Ph.D. — 74 Yorkminster Rd., Willowdale
Professor of Physics and Associate Chairman of the Dept. of Physics

W. C. Winegard, M.A.Sc., Ph.D. — 2143 Russet Rd., Cooksville
Professor of Metallurgical Engineering

DEPARTMENT OF INDUSTRIAL ENGINEERING

Professor and Head of the Department

A. Porter, M.Sc., Ph.D.(Manch.) — 61 Standish Avenue

Associate Professors

J. W. Abrams, A.B., Ph.D.(Calif.) — 120 Glen Rd.
B. Bernholtz, M.A., Ph.D.(Cal.I.T.) — 35 Westdale Dr., Downsview
D. J. Clough, B.A.Sc., M.B.A. — 75 Bridesburg Dr., Weston
S. Kotz, M.Sc., Ph.D.(Cornell) — 59 Spadina Rd.

Assistant Professor

R. W. P. Anderson, M.A.Sc. — 66 Aldershot Cres., Willowdale

Demonstrators (part-time)

J. E. Dooley — 170 Manor Rd. E.
J. W. Gilbert — 35 Delaware Ave.
W. J. Hummel — 186 St. George St.
P. R. Katey — c/o Dept. of Ind.Eng'g.
J. B. Levine — 1442 Lawrence Ave. W.
L. Magagna — 186 Stephen Dr.
S. Meslin — 26 Crang Ave.
M. J. M. Posner — 14 Markdale Ave.
D. Sadleir — 237 Poplar Plains Rd.
G. S. Tracz — 14 The Kingsway
S. Yagar — 730 Ontario St.

DEPARTMENT OF MECHANICAL ENGINEERING

Professor and Head of the Department

G. R. Lord, B.A.Sc., S.M.(M.I.T.), Ph.D. — 239 Dawlish Ave.

Professors

L. E. Jones, B.Sc.(C.E.) (Man.), M.A.Sc., Ph.D. — 29 Prince George Dr., Islington
I. W. Smith, M.A.Sc. — 2075 Annapolis Ave., Cooksville

Associate Professors

A. B. Allen, M.A.Sc. — 89 Waringstown Drive, Scarborough

W. D. Baines, b.sc.(alta.), m.s., ph.d.(iowa) 1675 Wedmore Way, Clarkson
F. C. Hooper, b.a.sc., d.i.c.(lond.) 92 Three Valleys Dr., Don Mills
P. B. Hughes, b.sc.(mcg.) 166 Douglas Drive
F. P. J. Rimrott, dipl.ing.(karlsruhe), m.a.sc., ph.d.(penn state), dr. ing. 22 Wallingford Rd., Don Mills
R. T. Waines, b.a.sc. 43 Albertus Ave.
W. A. Wallace, b.a.sc. 148 Duplex Ave.

Assistant Professors

B. M. M. Carpendale, m.a.(cantab.) Palermo
G. E. Godfrey, m.a.sc. 67 Westmount Avenue
J. F. Keffer, m.a.s.c., ph.d. 57 Chilton Rd.
H. J. Leutheusser, dipl.ing.(karlsruhe), m.a.sc., ph.d. 122 Torrance Rd., Scarborough
C. H. Miller, b.e.(n.s. tech.), m.a.sc., ph.d. Apt. 607, 15 Walmer Rd.
J. VandeVegte, dipl.ing.(delft), m.a.sc., ph.d. Apt. 401, 73 Coe Hill Dr.

Lecturers

D. L. Allen, b.sc.(dal.), b.e.(n.s. tech.), m.a.sc. 25 Overbank Crescent, Don Mills
E. Brundrett, b.s.a.(o.a.c.), b.a.sc., m.a.sc., ph.d. 36 Bernard Avenue
W. J. Moroz, m.a.sc. 6 Southill Dr., Don Mills
G. W. J. Pottow, b.sc.(lond.), m.s.(case) 20 Prince Arthur Ave.

Special Lecturers

J. P. Bruce, m.a. 6 River Valley Cr.
F. E. Burke, b.a.(lond.) 62 Duggan Ave.

Instructors

S. W. B. Black, b.a.sc. 88 St. Germain Avenue
M. Daschtschuk, m.a.sc. Massey College
A. Eidlitz, m.a.sc. 106 Alexis Blvd., Downsview
R. P. Henry, m.a.sc. (Apt. 806) 35 Thorncliffe Park Dr., Leaside
C. B. Rorke, b.sc.(mcg.) 120 Buckingham Avenue

Demonstrators

A. H. Abdelmessih, b.m.e.(cairo), m.s.(oklahoma state) (Apt. 501) 4 Grandstand Place
F. T. DeAbreu, b.sc.(london) 92 Frey Crescent, Scarborough
K. B. Elgohary, b.sc.(alexandria) (Apt. 921) 275 Shuter Street
T. J. Foster, b.a.sc. (Apt. 534) 10 St. Dennis Drive, Don Mills
A. R. Khan, b.sc.(aligarh) 60 Soudan Avenue
J. G. Lenard, b.a.sc. (Apt. 903) 267 St. George Street
V. G. Loscombe, b.a.sc. 22 Edgecroft Road
G. Nowikow, b.sc.(london) (Apt. 201) 5775 Yonge St., Willowdale
G. Parato, b.a.sc. 18 Crang Avenue
R. J. Royle, b.a.sc. 6 Blaine Drive, Don Mills
O. G. A. Schmidt, m.a.sc. 60 Bernard Avenue

P. Struk, B.A.Sc.(Mich. Tech. Univ.)
R.R. 2, Markham Rd., Scarborough
R. H. Temple, B.A.Sc. 26 Rykert Crescent
J. Unsworth, B.A.Sc. 27 Dalton Road
J. P. Veal, B.A.Sc. 25 Sunnylea Ave. E.
C. S. Wu, B.Sc.(Ordinance Eng. Col., Taipei) 54 Henry St.

Part-time Demonstrators

C. C. Alexopoulos, B.A.Sc. (Apt. 605) 224 St. George St.
V. H. H. Chu, B.Sc.(Nat. Taiwan) 58 Henry St.
R. S. Chow, B.Sc.(Cheng Kung) 8 Henry St.
S. K. Gupta, M.Sc.(Panjab), M.A. (Apt. 715) 700 Ontario Street
G. F. Hamilton, B.A.Sc., M.A. 18 Anglesey Blvd., Islington
R. T. Hartlen, B.Eng.(N.S.Tech.), M.A.Sc. 324 Palmerston Blvd.
D. Kaminker, B.A.Sc., M.S.(Polytechnic Inst. Brooklyn)
209 Ave Road
L. Y. Lau, M.A.Sc. 267 Glenforest Road
L. C. Lauzier, B.A.Sc.(Sherbrooke) 23 Kendal Avenue
H. Muensterer, Dipl.Ing.(Univ. Munich), M.A.Sc. 40 Walder Avenue
J. Peregrym, B.Sc.(Alta.) (Apt. 610) 437 Jarvis Street
B. D. Pratte, M.A.Sc. (Apt. 307) 77 Erskine Avenue
R. L. Sakaguchi, M.A.Sc. 822 Carlaw Avenue
V. Sernas, M.A.Sc. 8 High Park Blvd.
W. E. Watt, B.Sc.(Queen's), D.I.C.(Lond.), M.Sc.(Queen's)
(Apt. 201) 4 Grandstand Place
D. S. Weaver, B.A.Sc. (Apt. 704) 267 St. George Street

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

Professor and Head of the Department

L. M. Pidgeon, M.B.E., B.Sc.(Oxon.), Ph.D.(McG.), F.R.S.C.
185 Rosedale Heights Dr.

Professors

G. B. Craig, M.A.Sc., Ph.D. 10 Glenellen Dr. E.
W. C. Winegard, M.A.Sc., Ph.D. 2143 Russett Rd., Cooksville

Associate Professors

S. N. Flengas, B.Sc.(Athens), D.I.C.(Lond.), Ph.D.(Lond.)
60 Overbank Cresc., Don Mills
H. U. Ross, C.D., M.Sc.(McG.) 20 Blyth Hill Rd.

Assistant Professor

A. Plumtree, B.Sc., Ph.D.(Nott.) Apt. 705, 85 Lowther Ave.

Special Lecturer

B. Ramaswami, Ph.D.(Harvard) Apt. 301, 1071 Don Mills Rd.

Part-time Demonstrators

S. L. Bauer, B.A.Sc. 11 Fontenay Court, Islington
C. Beingessner, B.A.Sc. 2175 Avenue Rd.

M. C. E. Bell, M.A.Sc.	267 St. George St.
J. Carruthers, M.A.Sc.	75 Leacrest Rd.
G. G. Charette, B.Eng.(McG.), M.A.Sc.	14 Grandview Ave.
E. U. Chukukere, M.A.Sc.	53 Robert St.
J. I. Dickson, B.Eng.(McG.)	Massey College
J. E. Dutrizac, M.A.Sc.	389 Kingsdale Ave., Willowdale
A. K. Garbee, B.S.(Lafayette)	91 Wellesley St. E.
R. Gomez, B.A.Sc.	20 Acacia Rd.
H. Kerr, M.A.Sc.	Apt. 208, 404 Spadina Rd.
J. S. H. Lake, B.Sc.(Queen's)	108 Isabella St., Apt. 518
D. Mills, M.A.Sc.	605 Roehampton Ave.
L. Morris, B.A.Sc.	70 Leroy Ave.
P. C. Mullick, M.Sc.(Banares)	195 College St.
H. S. Ray, M.A.Sc.	38 Sussex Ave.
J. Skeaff, B.A.Sc.	89 Whitehall Rd.
P. K. Strangway, M.A.Sc.	359 Blythwood Rd.
B. Swaroop, M.A.Sc.	112 Baldwin St.
T. Toomver, M.A.Sc.	584 Huron St.
R. G. Williamson, B.Sc.(Queen's)	37 Sussex St.
J. R. Wynnyckyj, B.Eng.(McG.)	82 Tyrrell Ave.

DEPARTMENT OF MINING ENGINEERING

Professor and Head of the Department

H. R. Rice, B.Sc.(Qu.) — 9 Highbourne Rd.

Professor

S. E. Wolfe, M.A.Sc., P.Eng. — R.R. 1, Streetsville

Associate Professor

W. A. M. Hewer, B.A.Sc. — 68 Kingsway Cres.

Special Lecturer

Mrs. Helen Tucker, A.B., A.R.C.T. — 1524 Douglas Dr., Port Credit

Instructors

W. F. Gilman, B.S.(Syr.), M.A.	121 Combermere Dr.
F. C.-J. Lu, M.Eng.(N.S.)	22 Henry St.
W. J. Riddell, B.Sc.(Qu.)	12 Auchmar Rd., Hamilton

INSTITUTE FOR AEROSPACE STUDIES

Professor, and Director of the Institute

G. N. Patterson, B.Sc.(Alta), M.A., Ph.D., LL.D., D.Sc., F.R.Ae.S., F.C.A.S.I., F.A.I.A.A., F.R.S.C. — 81 Forest Grove Dr., Willowdale

Professors

J. H. de Leeuw, Dip.Ing.(Delft), M.S. in A.E.(Georgia Tech.), Ph.D. — 30 Valloncliffe Rd., Thornhill

B. Etkin, M.A.Sc., F.C.A.S.I. — 8 Bitteroot Rd., Downsview

I. I. Glass, M.A.S.C., PH.D., F.A.P.S., F.C.A.S.I.
39 Evanston Dr., Downsview
H. S. Ribner, B.S.(CAL. TECH.), M.S., PH.D.(WASH.), F.C.A.S.I.
24 Hawksbury Dr., Willowdale

Associate Professors
J. B. French, B.A.SC., M.SC.(BIRMINGHAM), PH.D.
138 Grandview Ave., Willowdale
G. K. Korbacher, DIP.ING.(BERLIN), PH.D.(BRAUNSCHWEIG)
24 Codsell Ave., Downsview

Assistant Professors
R. C. Tennyson, B.A.SC., M.A.SC. 50 Underhill Dr., Apt. 408
S. J. Townsend, B.A.(SASK.), M.A.(SASK.) 214 St. George St., Apt. 406
R. M. Measures, B.SC., A.R.C.S., D.I.C., PH.D.(LONDON)
Apt. 207, 711 Finch Ave. W., Downsview

Special Lecturers
I. J. Billington, B.A.SC., M.A.SC.(U.B.C.), PH.D.
45 Sun Row Dr., Weston
R. D. Hiscocks, B.A.SC., M.B.E., F.C.A.S.I. Box 28, Schomberg

Demonstrators
A. M. Drummond, B.A.SC., M.A.SC.(U.B.C.), D.C.Ae.(CRANFIELD)
205 Keele St., Apt. 310
L. T. Filotas, B.A.SC. 163 Humewood Dr.
E. K. Garay, B.A.SC. 57 Inwood Ave.
K. L. Hall, B.A.E., M.S.(RENSSELAER) 3330 Weston Rd., Apt. 205
J. L. Harris, B.A.SC. 163 Humewood Dr.
W. S. Hindson, B.A.SC. 220 Glengrove Ave. W.

SPECIAL LECTURERS

W. O. C. Miller, B.A.SC. Room 2400, 25 King St. W.
Special Lecturer in Engineering Law

PROFESSORS OF OTHER FACULTIES GIVING INSTRUCTION TO STUDENTS IN APPLIED SCIENCE

Professors
Miss E. J. Allin, M.A., PH.D.(Physics) 36 Willowbank Blvd.
F. E. Beamish, M.A., D.SC.(MCM), F.R.S.C. (Chemistry) 277 Heath St. E.
J. B. Currie, B.A.(MCM.), M.A., PH.D.(Geology)
4 Brynston Rd., Islington
D. B. De Lury, M.A., PH.D. (Mathematics) 7 Browside Ave.
G. F. D. Duff, M.A., PH.D., F.R.S.C. (Mathematics) 20 Buckingham Ave.
G. D. Garland, M.A.(TORONTO), PH.D.(ST. LOUIS), F.R.C.S. (Physics)
1 Forest Glen Cresc.
R. List, DIPL. PHYS. ETH., DR.SC. NAT.(ZURICH) (Physics)
162 Three Valleys Dr., Don Mills

L. E. H. Trainor, M.A.(Saskatchewan), PH.D.(Minnesota) (Physics)
93 Upper Canada Dr., Willowdale
Miss M. A. Fritz, B.A.(McG), M.A., PH.D., F.R.S.C. (Geology)
388 Brunswick Ave.
C. C. Gotlieb, M.A., PH.D. (Physics) 29 Ridgevale Dr.
T. C. Graham, M.B.E., B.A.Sc. (Bus. Admin.) 1 Rosedale Rd.
J. N. P. Hume, M.A., PH.D. (Physics) 51 Overton Cres., Don Mills
D. G. Ivey, M.A.(B.C.), PH.D.(Notre Dame) (Physics)
34 Yewfield Cres., Don Mills
Marcus Long, M.A., PH.D. (Philosophy) 39 Diana Dr., Downsview
K. G. McNeill, M.A., D.Phil.(Oxon.) (Physics) 227 St. Leonards Ave.
W. W. Moorhouse, M.A., PH.D.(Col.), F.R.S.C. (Geology)
138 Islington Ave. N., Islington
E. W. Nuffield, B.A., PH.D. (Geology) Thorncrest Village, Islington
J. C. Stryland, PH.D.(Amst.) (Physics) 9 Sutcliffe Dr., Willowdale
J. Van Kranendonck, PH.D.(Amsterdam) (Physics)
183 Three Valleys Dr., Don Mills
F. W. Watt, B.A., B.Litt., M.A., PH.D.(English) 24 Brendan Rd.
Y. J. Webber, B.A.(Cantab.) D.Sc.(Waterloo) (Mathematics)
18 Kappele Ave.
H. L. Welsh, M.A., PH.D., D.Sc., F.R.S.C., F.R.S. (Physics)
8 Tally Lane, Willowdale
J. T. Wilson, O.B.E., B.A., M.A.(Cantab.), PH.D.(Princ.), F.R.S.C.
(Physics) 29 Roxborough St. E.

Associate Professors

F. W. Beales, M.A.(Cantab.), PH.D. (Geology) 36 Nottingham Dr.
B. Brainerd, M.S., PH.D. 200 Roehampton Ave.
W. J. R. Crosby, M.A., PH.D. (Mathematics) 268 Queensway
C. Davis, B.S., M.A., PH.D. (Mathematics) 85 Crescent Rd.
R. E. Deane, B.A.Sc.(B.C.), PH.D. (Geology) 276 Lawrence Ave. E.
M. J. Dignam, B.A., PH.D. (Chemistry) 111 Highbourne Rd.
R. M. Farquhar, M.A., PH.D. (Physics)
1050 Burnhamthorpe Rd., R.R. 2, Cooksville
F. S. Grant, B.A.Sc., M.S.(Ill.), PH.D. (Physics) 8 Bayview Wood
W. H. Greub, M.A., PH.D. (Mathematics) 149 St. George St., Apt. 204
W. H. Gross, B.Sc.(B.C.), M.A., PH.D. (Geology) 25 Whitney Ave.
H. P. Gush, B.E., B.A., M.Sc.(Sask.), PH.D. (Physics) 11 Huntley St.
D. A. L. Paul, B.A.(Camb.), PH.D.(Qu.) (Physics)
P. A. Peach, B.Sc.(Edin.), M.A., PH.D. (Geology)
97 Truman Rd., Willowdale
R. Richmond, M.A., PH.D. (Physics) 62 Lurgan Dr., Willowdale
F. G. Smith, M.Sc.(Man.), PH.D. (Geology)
32 Pheasant Lane, Thorncrest Village
R. Wormleighton, B.A., PH.D.(Princ.) (Mathematics) 74 Spadina Rd.

Assistant Professors

R. L. Armstrong, M.A., PH.D. (Physics) 265 Russell Hill Rd.
R. G. Barradas, B.Sc.(Liverpool), PH.D.(Ottawa) (Chemistry)
9 Humewood Dr.

D. A. Clarke, m.a., ph.d. (Mathematics) 85 Lowther Ave.
S. S. Danyluk, m.sc.(manitoba), ph.d.(renss.) (Chemistry) 99 Kenwood Ave.
D. H. Gorman, b.sc.(n.b.), ph.d. (Geology) 69 Northdale Blvd.
W. R. Knight, m.a., ph.d. (Mathematics) 12 Kendall Ave.
A. D. May, m.a., ph.d. (Physics) 33 Chelford Rd., Don Mills
J. D. Poll, ph.d.(toronto) (Physics) 46 Plateau Cr., Don Mills
R. E. Pugh, m.a.(b.c.), ph.d.(iowa) (Physics) 214 George Street
K. B. Ranger, m.a., ph.d. (Mathematics) 125 Castlefield Ave.
E. A. Robinson, b.sc., ph.d.(london) (Chemistry) 650 Huron St.
R. A. Ross, m.a., ph.d. (Mathematics) 484 Church St.
D. K. Sen, m.sc., dr. ès sc. (Mathematics) 161 St. George St.
J. P. Valleau, m.a., ph.d.(cantab.) (Chemistry) 149 Collier St.
J. R. Vanstone, m.a., ph.d. (Mathematics) 139 Castlefield Ave.
G. F. West, b.a.sc., m.a., ph.d. (Physics) 67 Garfield Ave.
B. H. Worsley, s.m.(m.i.t.), ph.d.(cantab.) 55 Glenavy Ave.
Miss M. Wonenburger, ph.d.(yale), dr.math.(madrid) (Mathematics) 26 Thorncliffe Ave.
D. York, b.a., d.phil.(oxon.) (Physics) 515 Chaplin Cres.

SECTION IV. HISTORICAL SKETCH

The Legislature Assembly of the Province of Ontario during the Session of 1877 gave its sanction to the establishment of a School of Practical Science on the basis proposed in the memorandum of the Minister of Education confirmed by the Lieutenant-Governor in Council on February 3, 1877.

By the scheme thus approved the Government effected an arrangement with the Council of University College whereby the instruction given by its professors and lecturers in all departments of science embraced in the work of the School was made available to students of the School. This arrangement was brought to an end in 1889 by the transfer of the departments of science, above referred to, from University College to the University of Toronto under the operation of the University Federation Act. In order that the students of the School might continue to enjoy the advantage of the instruction of the above departments, the Senate of the University of Toronto passed a statute in October, 1889, affiliating the School with the University. The statute was confirmed by the Lieutenant-Governor on October 30, 1889.

By an Order-in-Council, approved by the Lieutenant-Governor on the 6th day of November, 1889, a Principal was appointed, and the management of the School was entrusted to a council composed of the Principal as chairman, and the Professors, Lecturers, and Demonstrators appointed in the Teaching Faculty of the School.

On December 14, 1900, the Senate, by statute subsequently approved by the Lieutenant-Governor in Council, established a Faculty of Applied Science and Engineering but without assuming any liability for its support or maintenance. Under this statute the teaching staff and examiners of the School of Practical Science became the teaching staff and examiners of the Faculty, although the University retained the right to appoint the examiners for the Bachelor of Applied Science and professional degrees. By the University Act of 1906 the School of Practical Science became the Faculty of Applied Science and Engineering of the University of Toronto.

On April 8, 1892, the Senate of the University established the Degree of B.A.Sc., which was open to those who held the Diploma of the School and were prepared to devote a fourth year to advanced work. In the Session of 1909–1910 a new course extending over four years and leading to the Degree of B.A.Sc., came into operation, taking the place of the long established diploma course of three years, which came to an end in the Session 1910–1911. In the session 1923–24 the degree was changed to B.Arch. for the students graduating in Architecture. On July 1, 1948, the School of Architecture was separated from the Faculty and became an independent School with its own Director and Council.

With the end of the Second World War during the summer of 1945 the University was faced with the difficult problem of providing accom-

modation for almost double the number of students that had been registered in the previous year. Through the efforts of the Chairman of the Board of Governors and the President, the University leased from the Crown part of the large shell-filling plant at Ajax, twenty-five miles east of Toronto, to relieve the heavy demand for space at Queen's Park. Because it became evident, at an early stage, that a relatively large number of students would register in the Faculty of Applied Science and Engineering, it was decided that the work of the First and Second Years of this Faculty should be given at Ajax.

A special First Year session with approximately 1,400 students commenced at Ajax on January 14, 1946. In the regular 1946–47 session both First and Second Year instruction, except Second Year in Architecture, was given at Ajax with 1,800 registered in the First Year and 1,500 in the Second Year. In the 1947–48 session the enrolment at Ajax consisted of 1,200 students in the First Year and 1,400 in the Second Year. In the session 1948–49, 600 were registered at Ajax in the First Year and 975 in the Second Year. All other instruction was given in Toronto.

To provide for this self-contained University community at Ajax, there were 446 acres and 111 buildings. The University operated such services as central heating, road maintenance, water supply, sewage disposal, fire department, transportation, post office, laundry, private hospital, cafeteria, tuck shop and barber shop. Former production-line buildings were altered to accommodate 37 lecture rooms, 20 draughting rooms and 14 laboratories. In the 1946–47 session, 2,300 students were in residence, in 1947–48 there were 1,800 students and in 1948–49 there were 900. Student life at Ajax compared favourably with that in Toronto, excellent accommodation being provided for a general circulating library, a technical library, Hart House Ajax, the Athletic Association, the Health Service, Students' Administrative Council, Advisory Bureau for Ex-Service Students, and a small chapel.

Meanwhile, the erection of the Wallberg Building and an addition to the Mechanical Building was in progress, and with this additional accommodation becoming available on the Queen's Park campus, Ajax was closed on May 31, 1949.

The long-felt need for additional space for Civil Engineering and Electrical Engineering, and the projected expansion of the University as a whole to meet the expected demand for greatly enlarged enrollment, led to the construction of the Galbraith Building. Partially occupied during the 1960–61 session it was officially opened on March 7, 1961, by the Honourable J. Keiller Mackay, D.S.O., V.D., Q.C., LL.D., D.C.L., Lieutenant Governor of Ontario. The building houses Civil Engineering, Electrical Engineering, the Institute of Aerophysics, and the Faculty Office.

SECTION V. GENERAL INFORMATION, ADMISSION AND REGISTRATION

Inquiries about admission to this Faculty should be sent to the Registrar of the University.

RESTRICTION OF REGISTRATION

The right is reserved to limit the number of students admitted to any course in the Faculty.

1. ADMISSION REQUIREMENTS

A candidate for admission to the first year must present the Ontario Grade XIII certificate or an equivalent certificate showing standing in the following subjects:

†*English:*	Literature Composition	
Mathematics:	Algebra Geometry Trigonometry	
Science:	Chemistry Physics	
†*One of:*	French German Greek Italian Latin Spanish Russian	*Authors and Composition*

†*In June 1965 the Grade XIII examination in English, French, German, Greek, Italian, Russian, Spanish, and Latin will consist of a single paper. For purposes of meeting the nine papers in the admission requirements for all courses, this examination will carry the weight of two papers in each of the subjects listed. The single mark will have the weight of two marks in determining the overall average mark.*

For admission to Civil, Mechanical, Industrial, Chemical, Electrical and Geological Engineering, and to Metallurgy and Materials Science, an overall average of at least 64% on these papers is required.

For admission to Engineering Science, an overall average of at least 70% on these subjects is required. Further information concerning the course in Engineering Science will be found on page 50 of this calendar. Students intending to pursue work in Aerospace Engineering will register in Engineering Science. For further information, refer to pages 50 and 69.

Preferential consideration will be given to candidates who have completed the University admission requirements at the end of one session in Grade XIII in Ontario schools or in one sitting in other school systems. Applications will also be considered in the light of the Principal's Report,

the previous school record of the applicant and other tests of the student's ability that are available.

2. EQUIVALENT CERTIFICATES

The following certificates are usually accepted as equivalent to Ontario Grade XIII although individual subjects cannot always be equated. Specific details on the standing required in particular cases will be supplied on request.

CANADA (Standing as outlined in (1) above is required on the following certificates from Canadian provinces):

Alberta, Manitoba, Nova Scotia, Saskatchewan—Grade XII.

British Columbia, New Brunswick—Senior Matriculation.

Newfoundland—First Year Memorial University.

Prince Edward Island—Third Year Certificate of Prince of Wales College.

Quebec—Senior High School Leaving Certificate; McGill Senior School Certificate; English Catholic Senior High School Leaving Certificate (5th Year High—Grade XII). Other certificates will be considered.

ENGLAND, WEST INDIES, EAST AND WEST AFRICA:

(i) General Certificate of Education showing either

(a) Passes in five subjects of which at least two must be passed at advanced level; or

(b) Passes in four subjects of which at least three must be passed at advanced level.

In either case, passes are required in Physics, Chemistry, and an acceptable mathematical subject. At least two of these must be at advanced level.

or (ii) School and Higher School Certificates, which are equated to the General Certificate of Education as follows, and accepted on that basis:

Credits on the School Certificate are accepted as ordinary level passes on the General Certificate of Education; subsidiary passes on the Higher School Certificate as ordinary level passes on the General Certificate of Education; and principal or main subject passes on the Higher School Certificate as advanced level passes on the General Certificate of Education.

HONG KONG:

General Certificate of Education or School and Higher School Certificates as stated above; or University of Hong Kong Matriculation Certificate, accepted on same basis as General Certificate of Education.

UNITED STATES OF AMERICA:

First Year University credits (a minimum of 30 semester hours) in the required subjects from accredited institutions of higher

learning. A United States High School Graduation Diploma will not normally admit a candidate to any course. Advanced Placement work will, however, be considered.

Candidates seeking admission on the basis of certificates which are in a language other than English must submit photostatic copies of their certificates, rather than the original copies. Notarized English translations of the certificates must accompany the photostatic copies. When the certificates do not indicate the subjects studied and the grades secured in the individual subjects in the final year, candidates are required to submit certified statements from authorized officials of the institutions attended, or submit statutory declarations giving the required information.

3. ENGLISH FACILITY REQUIREMENTS

All applicants are required to submit evidence acceptable to the University of Toronto of facility in English. The following evidence is acceptable:

(*a*) The University of Michigan English Language Test. This test is available at the University of Toronto for residents of the Toronto area. Enquiries about writing the test in Toronto should be addressed to the Department of Admissions, Simcoe Hall, University of Toronto.

(*b*) The Certificate of Proficiency in English issued by the Universities of Cambridge or Michigan.

Information about writing the tests in (*a*) or (*b*) above in overseas centres may be obtained from the Department of Admissions, Simcoe Hall, University of Toronto.

(*c*) Standing in English Composition in the Ontario Grade XIII Certificate, or other certificates recognized by the University of Toronto as equivalent.

The University is prepared to consider other evidence of English facility which may be submitted for evaluation to the Registrar of the University.

4. MATURE STUDENTS

(*a*) *Admission Regulations*

Candidates of mature age (30 years or older on October 1 of the regular session, or July 1 of the summer session, to which admission is sought) who have lived in Ontario for a minimum period of one year, and are normally resident in Ontario, may request special consideration if they have not completed in full the published Grade XIII (or equivalent) requirements. Such applicants must submit a birth certificate at the time of application.

(*b*) *Probationary Status*

Candidates accepted by the Senate's Committee on Admissions as mature students are admitted on probation.

Mature students, registered in full-time day courses, must obtain standing in their first year of full-time study in order to have their probationary status removed. If they do not obtain standing they

will not be allowed to repeat the year or to enrol in any other degree or diploma course in the University until they present in full the published admission requirements.

5. CANDIDATES FOR FIRST YEAR

(a) *Procedure for Application*

A candidate seeking admission to the First Year must submit the following to the Admissions Department, Office of the Registrar, Simcoe Hall:

(i) A completed application form.

(ii) If entering direct from secondary school, a confidential report to be sent direct from the school to the Registrar.

(iii) Senior Matriculation Certificates:

Ontario Grade XIII students or graduates must submit with their applications all Grade XIII certificates issued in 1964 or earlier.

High-school graduates presenting Senior Matriculation Certificates other than Ontario Grade XIII must submit with their application any official Senior Matriculation Certificates already held. These certificates must indicate the subjects studied and the grades obtained. Certificates which will be available later in the year must be provided as soon as they are issued.

(iv) In addition to (i), (ii) and (iii), a student who has previously attended a University must submit the following whether the candidate has passed, failed or withdrawn:

(*a*) Official transcripts issued by the University or College previously attended, giving in detail the courses completed, with the standing and grades in each. Transcripts or a supporting letter from the Registrar of the University or College must indicate that the candidate has been granted honourable dismissal and is eligible for selection to the institution concerned in the session for which he seeks admission to the University of Toronto; and

(*b*) Official statements or calendars giving full information on the content of the University courses covered by the transcripts submitted.

Candidates who are not certain that they meet the published admission requirements should communicate with the admissions department, Office of the Registrar, giving full details regarding their academic standing, before submitting formal applications.

Applications for admission should be submitted as early as possible in the year for which the candidate seeks admission.

(b) *Terminal Dates for Submission of Applications and Certificates*

1. March 1, 1965—Applications for Provisional Admission (See Section 6).

2. June 1, 1965—All other applications. Only in circumstances which the Committee on Admissions deems exceptional will a late application be considered.
3. Aug. 16, 1965—All certificates which have been issued before this date.
4. Sept. 1, 1965—Certificates issued on or after Aug. 16, 1965.

6. PROVISIONAL ADMISSION ARRANGEMENTS (Ontario Applicants for First Year)

Ontario Grade XIII students wishing to avail themselves of the Provisional Admission procedures, which will provide by June to First Year applicants notification of Provisional Admission, must forward their applications by March 1st. They must also request their School Principals to submit the completed Confidential Report Form by that date.

Only a limited number of the available student places in the University are offered under the Provisional Admission arrangements. All applicants who pass the Ontario Grade XIII examinations with the published admission requirements are eligible for selection to the University.

7. APPLICATION FOR ADMISSION WITH ADVANCED STANDING

A candidate seeking admission on an advanced standing basis must submit to the Department of Admissions, Office of the University Registrar, Simcoe Hall, prior to the dates mentioned above, his completed application form and the documents outlined in 5 (*a*) (iii) and (iv).

8. ADMISSION REGULATIONS CONCERNING CANDIDATES WHO HAVE PREVIOUSLY FAILED IN UNIVERSITY WORK

(*a*) A candidate who, on one occasion has failed to secure the right to advance to a higher year at the University of Toronto or at any other institution of higher learning, may be eligible for selection to the University of Toronto subject to warning of probable required withdrawal from his Faculty and possible debarment from the University on a second failure.

(*b*) A student who on two occasions has failed to secure the right to advance to a higher year at the University of Toronto will normally be refused readmission to his faculty and may be debarred from registration in any division of the University of Toronto. Candidates with two such failures at other institutions will normally be refused admission.

9. PROCEDURE FOR REGISTRATION

Detailed instructions concerning Registration and Health Requirements will be mailed to returning and newly admitted students before the beginning of each academic year.

10. HEALTH REQUIREMENTS

Every person admitted to the University as an undergraduate must, at the time of his or her first medical examination by the University Health Service, present satisfactory evidence of successful vaccination within three years prior to the date of the examination, or must be vaccinated by the examining physician.

11. PROCEDURES FOR WITHDRAWALS OR TRANSFERS

A student who wishes to withdraw or to transfer his course or division in the University should consult his College Registrar or Faculty/School Secretary.

12. REGULATIONS OF THE UNIVERSITY CONCERNING PENALTIES FOR UNSATISFACTORY WORK BY STUDENTS

(*a*) In cases of unsatisfactory work of a very serious nature, a faculty Council may recommend to the Senate Committee on Admissions that a student shall be debarred from the University.

(*b*) A faculty Council should, except in very exceptional circumstances, refuse to re-admit to that faculty any student who on two occasions fails to secure the right to advance to a higher year in that faculty or a like faculty.

(*c*) A faculty Council may for unsatisfactory work suspend a student from regular attendance in that faculty for a given period of time not exceeding two years and/or until the satisfaction of other conditions as it may see fit. Upon satisfying the conditions of the suspension the student shall be entitled to re-enrolment in that faculty.

(*d*) Any student who withdraws after February 15, or who does not withdraw but does not write the annual examinations, will be regarded for the purposes of these regulations as having failed his year.

13. APPEALS

A student wishing to appeal to the Senate against a decision of a faculty or school council should consult the secretary of the faculty or school, the registrar of the college, or the office of the university registrar about the preparation and submission of his petition to the Secretary of the Senate.

COLLEGES

With the establishment of New College and Innis College, which are open to students of all faculties, it is now possible for students of the Faculty of Applied Science and Engineering to become members of a college. Membership in a college is not obligatory, and application for membership is at the option of the student.

Students entering the First Year who are interested in becoming members of either college should indicate their choice in the space provided on the University's admission application form. A college fee of $15 is required upon acceptance.

The facilities of Innis College and New College are described below.

INNIS COLLEGE

Innis College was constituted on July 1, 1964, and admitted its first students in the following September. It is a multi-faculty college of the University of Toronto, and includes undergraduate students in all Faculties and Schools of the University. In the academic session 1965–66, only First and Second Year students may apply for membership in the College.

A special feature is the Writing Laboratory. This service offers assistance to Innis College students in the skills and methods of writing essays and other academic reports. A staff of experienced teachers is available to give individual instruction.

NEW COLLEGE

New College is a multi-faculty co-educational college; in addition to students from the Faculty of Arts and Science those from other Faculties and Schools are eligible for membership. This gives students from all divisions of the University the opportunity to participate in the life of a college and to associate with students in other fields of study. Tutorial classes are provided for First Year students in some subjects.

The new building, centrally located on the west campus, provides academic, social and dining facilities for all members of the College and in addition accommodates nearly 300 male students in residence.

Students applying for membership in the College who wish accommodation in the Residence must apply on the prescribed form which may be obtained from the Dean of Students, New College.

RESIDENCE ACCOMMODATION

DEVONSHIRE HOUSE

Devonshire House, the University Residence for Men, accepts students from all Faculties. The facilities of the residence include a library, music listening room, music practice room, common rooms, kitchenettes, laundry room, television and games rooms. It does not have a dining hall. Members may take their meals at Hart House, Howard Ferguson Hall, or New College, all located nearby.

Application forms may be obtained from the Secretary to the Dean, Devonshire House, University of Toronto. Application should be made as early as possible.

NEW COLLEGE

The residence facilities of New College, and the procedure for application, are described in the entry under Colleges, above.

Each of the four Arts Colleges also maintains a Men's Residence, into which some engineering students may be accepted. Further information may be obtained from

University College—Dean of Men
Victoria College—Senior Tutor
Trinity College—Registrar, Trinity College
St. Michael's College—Dean of Residence

HOUSING SERVICE

For the convenience of those students who are not able to find accommodation in the University and College residences, the University maintains a listing of rooming houses, flats, apartments and homes. Information on these rooms may be obtained through the Housing Service office at 581 Spadina Avenue, Toronto 4.

Off-campus housing of this nature is not subject to University regulation. However every effort is taken to make the information on the accommodation as complete as possible and students are encouraged to assist in this effort by reporting on the quality of the accommodation that they have occupied.

CAMPUS CO-OPERATIVE RESIDENCE

The Campus Co-operative Residence, Inc. offers certain housing accommodations for undergraduate and graduate students. Since the University of Toronto has no official connection with the Campus Co-operative Residence, Inc., inquiries about accommodation available through that organization should be addressed directly to:

Campus Co-operative Residence, Inc.,
395 Huron Street,
Toronto 5, Ontario.

SECTION VI. FEES, DEPOSITS AND EXPENSES

FEES

1. A student who desires to enrol in the Faculty of Applied Science and Engineering is required to pay at least the First Term Instalment of fees on or before the opening date of the session, and before he can receive his admit-to-lectures card from the Secretary of the Faculty. The amount of the First Term Instalment of fees or of the Total Fee for the session may be ascertained from the schedule of fees below.

2. The Second Term Instalment of fees, if not already paid, is payable on or before January 15. After this date an additional fee of $3 per month or portion thereof (not exceeding $10), will be imposed until the whole amount is paid. All fees for the session must have been paid in full before the student can be admitted to the annual examinations.

3. In order to avoid delay in registration at the opening of the session it is recommended that at least the First Term Instalment of fees be forwarded by mail as early as possible in September, together with a form, in duplicate, to be provided by the Secretary of the Faculty and filled out by the student, giving his full name, course, year, etc.

4. During the period from August 3 to September 18 inclusive, the Chief Accountant will receive tuition fees in Cody Hall, School of Nursing from 9 a.m. to 5 p.m. Monday to Friday, and on Saturday morning, September 18, from 9 a.m. to 12 noon. Following this date, payment of fees will be made at the Office of the Chief Accountant, 215 Huron St. Cheques in payment of fees should be made payable to the University of Toronto at par in Toronto.

5. Each undergraduate enrolled in the Faculty of Applied Science and Engineering must pay annual fees to the Chief Accountant according to the schedule below; the total fee in each case is made up of the academic fee and incidental fees; all incidental fees are payable in the first term.

Schedule of Fees

Men

Academic Year	*Academic Fee	†Incidental Fees	Total Fee (if paid in one instalment)	First Term Instalment	Second Term Instalment
I-IV	$650	$63	$713	$388	$328

Women

I-IV	$650	$35	$685	$360	$328

*The Academic Fee includes the following fees:
Tuition; Library and Laboratory Supply; one Annual Examination; Laboratory Fee; Physical Education; and Degree.

†These Incidental Fees include the following fees:
For men—Hart House; Students' Administrative Council; Athletic; Health Service; Engineering Society; Faculty Athletic Association.
For women—Students' Administrative Council; Athletic; Health Service; Engineering Society.

LATE REGISTRATION FEE

6. Any student who registers after the last date for normal registration in his or her own faculty or school is required to pay a late registration fee of $10 plus $1 for each day of delay to a maximum of $20.

OTHER UNIVERSITY FEES

7. Each student is required to pay to the Chief Accountant at the opening of the session, or as otherwise specified, such of the following fees as may be required of him.

EQUIVALENT CERTIFICATE FEE

8. Each student who has been admitted to the First Year upon a certificate or certificates granted outside the Province of Ontario and covering all or any part of the admission requirements, must pay a fee of $5.

ADVANCED STANDING FEE

9. Each student who has been admitted to advanced standing from another university or college, must pay a fee of $10.

SPECIAL PHYSICAL EDUCATION FEE

10. Each student who has neglected to complete satisfactorily the course in Physical Education of the First Year must pay an additional fee of $50 at the beginning of the next session in which he is registered. This fee will be refunded if the student satisfactorily completes the required programme in that session.

SPECIAL STUDENTS FEES

11. The fee is $95 per subject, payable to the Chief Accountant.

SUMMARY OF STUDENTS' EXPENSES

13. The following approximate statement of expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering in the University of Toronto, exclusive of personal expenses:

1. Fees, see schedule page 32.
2. Board and Lodging, per week .....$20 up
3. Books and instruments, per year .....about $100

CHILDREN OF WAR DEAD (EDUCATION ASSISTANCE) ACT

Children of War Dead (Education Assistance) Act provides fees and monthly allowances for children of veterans whose death was attributable to military service. Enquiries should be directed to the nearest District Office of the Department of Veterans Affairs.

SECTION VII. COURSES AND DEGREES

1. At the time of registration in the Faculty, the applicant is required to indicate the graduating course in which he intends to proceed to a degree. There are eight courses in Engineering, from which the selection may be made, viz.,

Civil Engineering (Course 1),
Mechanical Engineering (Course 3),
Industrial Engineering (Course 4),
Engineering Science (Course 5),
Chemical Engineering (Course 6),
Electrical Engineering (Course 7),
Metallurgy & Materials Science (Course 8),
Geological Engineering (Course 9),
Aerospace Engineering (see page 69).

2. The Degree of Bachelor of Applied Science will be awarded to students who complete one of the above courses.

3. The courses extend over four academic years. A student must pass in the work of each academic year before proceeding to the work of the next. See Sec. IX.

4. If, for any reason, an undergraduate wishes to change his course, he must petition the Faculty Council and obtain its approval. Such petition should be submitted by September 15.

5. Students must conform to all lecture room and laboratory regulations. Reports, briefs, theses, and drawings become the property of the Council to dispose of as it may see fit. Drawings, briefs, and field notes will not be accepted unless they have been made at the time and place provided in the time-table.

6. The curricula of the courses of instruction are given in Sec. VIII.

7. Examinations are conducted as explained in Sec. IX.

8. Students in Civil Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering, Metallurgy and Materials Science and Geological Engineering are required to have practical experience in offices, shops, or field, before their degree is granted. Students are asked to submit certificates of this experience as soon as possible after the completion of each period of work. (See Sec. VIII.)

GRADUATE STUDY AND RESEARCH

Facilities are available in the Departments of the Faculty, for graduates with good records of this University or of another University of comparable standing, for post-graduate study and research leading to the degrees of Master of Applied Science (M.A.Sc.) and Doctor of Philosophy (Ph.D.). For further information see the Calendar of the School of Graduate Studies. Many graduate students receive financial support for equipment, and salaried appointments as research assistants,

through a variety of research grants originating both within and outside the University.

Bursaries and Scholarships for graduate students are available in limited number as shown on page 139. Many part-time demonstratorships are open which permit post-graduate work towards a degree.

DIPLOMA COURSE IN OPERATIONS RESEARCH

A one-year diploma course in Operations Research is offered for those who have obtained a bachelor's degree in engineering, science, or mathematics. The diploma course is designed specifically to meet the needs of people who are presently employed in industry and who aspire to develop special skills in the design, analysis, and control of complex organizational systems.

Inquiries regarding the Diploma Course in Operations Research should be directed to the Secretary, Faculty of Applied Science and Engineering.

SPECIAL STUDENTS

Graduates of the University of Toronto and of recognized universities who wish to take one or more undergraduate subjects may be registered as special students in the Faculty of Applied Science and Engineering, subject to the approval of the teaching department concerned. Application must be made to the Secretary of the Faculty.

INTERIM HIGH SCHOOL ASSISTANT'S CERTIFICATE TYPE A

Graduation in Engineering Physics is accepted by the Ontario College of Education as meeting the academic requirements for admission to the course leading to a Type A certificate in Mathematics and Physics.

Graduates in other engineering courses may also be admitted to Type A Certificate courses at the Ontario College of Education if they submit official transcripts which indicate that they have sufficient academic credits.

Graduates in engineering courses who lack sufficient academic credits for admission to Type A courses at the Ontario College of Education may be eligible for admission to the Type B course and later for endorsement of the Type B Certificate in Mathematics and Physics.

Inquiries regarding endorsement of Type B Certificates or admission to Type A Certificate courses should be directed to the Director, Advanced Academic Recommendations, Ontario College of Education.

ASSOCIATIONS OF PROFESSIONAL ENGINEERS

Graduation from the Faculty of Applied Science and Engineering leads to registration as a Professional Engineer in the various Associations of Professional Engineers throughout Canada.

SECTION VIII. CURRICULUM

The courses are designed to give the student a thorough grounding in the fundamentals of engineering, with emphasis on their practical application in the field in which he has chosen to study. In the First Year there is little differentiation between the various courses with the exception of Engineering Science. In the succeeding years, specialization develops to a considerable extent, with provision in the Third and Fourth Years for optional subjects in some of the courses.

The Faculty has excellent laboratory facilities, in which the students do practical experiments and problems related to the lecture subjects. In some graduating courses, laboratory work in the Fourth Year consists of the investigation of some specific problem. In all instances, the student's knowledge of the original literature and primary sources of information is extended, and he is given a very desirable and useful training in methods of research. As part of the laboratory instruction, excursions to places of technical interest are arranged by the staff. These excursions are treated as laboratory periods, with the same requirements as to attendance and reports.

As in the case with other professions, the engineer should be prepared to assume positions of professional and community leadership. Accordingly, the curriculum contains a basic core of humanistic-social studies, including English, Political Science, Economics, Modern History, and Philosophy of Science. It is hoped that this introduction to the humanities will stimulate the student to do further reading and study, thereby increasing his professional effectiveness.

On the following pages of this section, the curriculum for each course is set forth in detail. The time devoted to lectures and practical work is indicated as accurately as possible, but is subject to modification as occasion may require. The programme and regulations regarding the courses of study and examination, contained in this Calendar, hold good for this academic year only, and the Faculty of Applied Science and Engineering does not bind itself to adhere for the whole period of a student's course to the conditions here laid down.

Communications relating to curicula, instruction, and examinations in the Faculty of Applied Science and Engineering should be sent to the Secretary of the Faculty.

For information regarding the courses of study leading to the post-graduate degrees, Master of Applied Science, and Doctor of Philosophy, see the calendar of the School of Graduate Studies, which gives full particulars.

FIRST YEAR CURRICULUM

The courses in Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering and Metallurgy and Materials Science, designated as Division A have a common First Year and the courses in Civil Engineering and Geological Engineering have a common First Year differing from that of Division A only in that Surveying is included. The First Year curriculum in Engineering Science is designated as Division C.

A student, on petition to the Council, may be permitted to change his course at the end of the First Year.

FIRST YEAR CURRICULUM

Division A		Division B
Mechanical Engineering Industrial Engineering Chemical Engineering Electrical Engineering Metallurgy and Materials Science	AND	Civil Engineering Geological Engineering

First Year Subjects Divisions A & B	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	600,601	2	3	2	3
Engineering Problems and Drawing	137	–	6	–	6
English	2110	2	–	2	–
Mathematics:					
Calculus, Analytical Geometry and Algebra	2410	3	3	3	3
Descriptive Geometry	135	1	–	1	–
Physics:					
Electricity	700, 2502	2	3	2	3
Mechanics	100, 2502	2		2	
Structure and Properties of Matter	2501, 2502	2		2	
Physical Education	3110	–	2	–	2
Practical Experience	10	–	–	–	–
Surveying (Division B only)	150, 151	1	3	–	–

DIVISION C
Engineering Science

FIRST YEAR SUBJECTS DIVISION C	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	602, 601	2	3	2	3
Engineering Problems and Drawing	142	–	3	–	3
English	2110	2	–	2	–
Mathematics:					
Algebra and Geometry	2415	2	3	2	3
Calculus	2416	2		2	
Descriptive Geometry	135	1	–	1	–
Physics:					
Electricity	701	2	–	2	–
Statics	101	2	–	–	–
Properties of Matter; Mechanics and Heat	2511, 2512	3	4	3	4
Physical Education	3110	–	2	–	2

CIVIL ENGINEERING

(COURSE 1)

The course in Civil Engineering has been so designed as to be broad and comprehensive. It has been designed not only to meet the needs of those who have definitely decided to enter this branch of the profession, but also of those who desire an engineering education of such a basic character as to enable them to enter various other fields of engineering employment.

In addition to instruction in engineering subjects, sufficient time is assigned to economic, legal and administrative studies to qualify the graduate in this course not only to engage in any of the branches of Civil Engineering but also to do administrative or executive work in industrial, commercial, government or other undertakings of an engineering character.

In the final year four options are offered:

A—Structural
B—Surveying
C—Municipal and Sanitary
D—Transportation and Soil Mechanics

Because of the common core of Civil Engineering material in the course, a graduate in any option will not be at a serious disadvantage when engaged in engineering work that is more closely associated with one of the other options.

Most of the subjects in the Third Year are taken by all students, but, in addition to these common subjects, students proceeding to options A, C, and D in the Fourth Year must take the Group A subjects while those proceeding to option B must take the Group B subjects.

The subjects of instruction are shown in the following tables. In these tables numbers have been assigned to the subjects which refer to a more detailed description of each, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION B, see page 37.

Second Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Alternating-Current Circuits	717, 718	2	1½	–	–
Calculus	2420	2	–	2	–
Dynamics	350	–	–	2	–
Economics	2720	2	–	2	–
Engineering Chemistry	607	2	–	–	–
Engineering Geology	2906, 2907	2	–	1	3
Engineering Thermodynamics	302	–	–	2	–
Engineering Problems and Drawing	138	–	6	–	6
Mechanics of Materials	105, 104	2	–	2	3
Physical Metallurgy	815	–	–	2	–
Physical Principles of Heat and Optics	2525	2	1½	–	–
Practical Astronomy	157	–	–	2	–
Practical Experience	10	–	–	–	–
Surveying	153, 154	2	3	1	3

Each student in Civil Engineering is required to state, not later than June 30 following the completion of his Second Year, the group of subjects he desires to pursue in the Third Year. Permission to take either group of subjects must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Third Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Fluid Mechanics	333, 334	2	–	2	3
Highway Engineering I	185, 195	2	1½	–	–
Engineering Mathematics	141, 139	2	1½	2	3
Municipal Planning, Administration and Transportation	186	–	–	3	–
Practical Experience	10	–	–	–	–
Sanitary Engineering	180	2	–	–	–
Soil Mechanics	191, 195	2	1½	–	–
Survey Camp	158	–	–	–	–
One of					
Modern World History	2330	2	–	2	–
Political Science	2730				
And either of the following groups of subjects:					
Group A (Leading to options 1A, 1C and 1D)					
Mechanics of Materials II	110, 113	2	7½	2	6
Structural Design I	111, 113	2		2	
Structural Theory I	112, 113	–		3	
Group B (Leading to option 1B)					
Geodetic Engineering	160, 161	–	–	2	3
Least Squares	159	–	3	–	–
Photogrammetry I	162, 163	2	3	–	–
Photo Interpretation	164, 165	–	–	2	3
Structural Engineering I	114, 115	2	1½	2	3

Civil Engineering students selecting the Group A subjects are required to state not later than June 30 following the completion of their Third Year the options (one of options 1A, 1C or 1D) they desire to pursue in the Fourth Year. Permission to enter upon an option must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Civil Engineering students selecting the Group B subjects in their Third Year must pursue option 1B in their Fourth Year.

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Construction Management and Business	130	–	–	2	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
And one of the following options:					
OPTION 1A (Structural)					
Behaviour and Design of Steel Structures	118	2	–	2	–
Hydraulic Engineering	343	–	–	2	3
Mathematical Applications	140	2	–	–	–
Reinforced Concrete I	116	2	–	2	–
Reinforced Concrete II	117	2	–	2	–
Soil Mechanics and Foundations	192, 196	2	–	1	2
Structural Theory II	119	2	–	3	–
Thesis Project, Laboratory and Seminar	20, 120	–	12	–	10
OPTION 1B (Surveying)					
Geodetic Adjustments	168, 169	1	3	1	3
Photogrammetry II	170, 171	1	3	1	1½
Astronomy	172, 173	1	3	–	–
Engineering and Legal Surveys	174	2	–	1	–
Geodesy and Electronic Surveying	175, 176	2	1½	2	3
Hydraulic Engineering	343	–	–	2	3
Structural Engineering II	122, 123	2	4½	2	3
Survey Camp	167	–	–	–	–
Town and Regional Planning	3540, 3541	1	3	1	3
Thesis	20	–	–	–	1

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 1c (Municipal and Sanitary)					
Air and Water Resources	181	2	–	3	–
Traffic Engineering	187	–	–	2	–
Hydraulic Engineering	341, 342	2	1½	2	3
Mathematical Applications	140	2	–	–	–
Municipal Engineering and Planning; Sanitary Chemistry	182	2	–	2	–
Reinforced Concrete I	116, 121	2	3	2	3
Soil Mechanics and Foundations	192, 196	2	–	1	2
Thesis Project, Laboratory and Seminar	20, 183	–	7½	–	7
Option 1d (Transportation and Soil Mechanics)					
Air Photo Interpretation	189, 197	1	3	–	–
Traffic Engineering	187	2	–	–	–
Hydraulic Engineering	343	–	–	2	3
Mathematical Applications	140	2	–	–	–
Pleistocene Geology	2936	2	–	2	–
Reinforced Concrete I	116, 121	2	3	2	3
Soil Mechanics and Foundations	192, 196	2	2	1	–
Transportation Engineering	188	1	–	2	–
Earth Structures and Foundations	193	1	–	2	–
Thesis Project, Laboratory and Seminar	20, 198	–	4	–	9

MINING ENGINEERING

(Course 2)

The Mining Engineer is concerned with all aspects of the winning of metals and minerals from their geological environments in the earth's crust, and of their conversion to forms in which they can best be utilized in the growing needs and comforts of man. Thus, the course in Mining Engineering has been devised to prepare its graduates for successful participation in the engineering, operational, and administrative activities of those aspects.

The Mining Engineer has been traditionally concerned with the fields of mineral exploration, evaluation and development of mineral properties, the mining and treatment of ores, and the economics of mineral markets. Owing to the gradually changing aspect of engineering education at the undergraduate level, it has become desirable to transfer the work associated with these fields to the post-graduate level, and thus the undergraduate course in Mining Engineering will be progressively discontinued. Instruction in the First Year will not be offered in the Session 1965–66. Graduate study and research, in collaboration with other Departments in the Faculty, will be encouraged.

Building upon a foundation in the disciplines of mathematics, physics, and chemistry, the student proceeds through training in geology, mechanics, electricity, economics, business, and general engineering subjects, to a growing proportion of specifics dealing with the fields which the course is designed to serve. The diversification of this training renders the Mining Engineer capable of successful participation in all branches of industry and commerce.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 130.

Second Year Subjects Course 2	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
A. C. Circuits I	717, 718	2	1½	–	–
Analytical Chemistry Laboratory	606	–	6	–	–
Calculus	2420, 144	2	1½	2	1½
Chemistry	605	2	–	–	–
Economics	2720	2	–	2	–
Historical and Stratigraphic Geology	2930	–	–	2	1
Mechanics of Materials	105, 104	2	–	2	3
Mineralogy and Lithology	2910, 2911	2	2	2	2
Mining	221	1	–	1	2
Geology	2900, 2901	2	3	–	–
Practical Experience	10	–	–	–	–
Surveying	155, 156	1	3	2	2

Third Year Subjects Course 2	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Assaying	201, 202	1	3	1	3
Elementary Structural Engineering	124, 125	1	–	2	3
Fluid Flow and Pumping Systems	335, 336	3	3	–	–
Geological Field Work	2983	–	–	–	–
Engineering Thermodynamics	306, 307	1	–	1	3
Metallurgy	804	–	–	1	–
Mineral Dressing	241, 243	2	–	2	6
Mining	222	1	–	2	–
Mining Laboratory	223	–	3	–	2
Operations Research	412, 413	2	1½	–	–
Practical Experience	10	–	–	–	–
Structural Geology	2950, 2951	1	3	1	3
Summer Essays	261	–	2	–	–
Survey Camp	158	–	–	–	–
Wet Analysis	203	–	3	–	3
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–

Fourth Year Subjects Course 2	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
English	2140	1	–	1	–
Glacial Geology and Ground Water	2934, 2985	1	–	1	–
Machine Design	371, 372	1	–	1	3
Metallurgy	808, 809	1	–	1	3
Mine Operation and Administration	224, 225	2	2	2	6
Mineral Deposits	2960	2	–	2	–
Mine Ventilation	321, 251	2	3	–	–
Mining Geology	2968	–	–	2	–
Ore Dressing	244, 245	1	6	1	–
Physical Metallurgy	815	–	–	2	–
Practical Experience	10	–	–	–	–
Precambrian Geology	2944, 2945	2	1	–	–
Philosophy of Science	2040	2	–	–	–
Thesis Project, Laboratory, and Seminar	20, 275	–	$5\frac{1}{2}$	–	6

MECHANICAL ENGINEERING

(Course 3)

Traditionally associated with the art and science of power generation and the machines and devices by which power is usefully applied and controlled, Mechanical Engineering, like other branches of the engineering profession, participates actively in the advancement of knowledge and interprets this knowledge in the design and development of practical systems.

In manufacturing industry, in the transportation and power utilities, in the high-performance field of air and space engineering, or in engineering aspects of major works and structures, the mechanical engineer finds professional occupation, either as employee or consultant. His responsibility will generally be for the superintendence of operations and personnel, for the design of products and processes, and may include the administration of enterprises.

The curriculum in Mechanical Engineering provides an analytical training in mathematics and the physical sciences designed as a disciplinary basis for active professional practice. Recognition is given, however, to the purer scientific and philosophical concepts essential to postgraduate study and research.

The subjects of instruction are shown in the following tables, in which the assigned Subject Numbers refer to the more detailed descriptions given later, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION A, see page 37.

Second Year Subjects Course 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Alternating-Current Circuits	717, 718	–	–	2	1½
Calculus	2420	2	–	2	–
Dynamics of Machines	357	3	–	3	–
Economics	2720	2	–	2	–
Electricity	714, 713	2	3	–	–
Engineering Chemistry	607	2	–	–	–
Heat Engineering, Elementary	303	–	–	2	–
Machine Design	356, 358	–	6	2	6
Mathematical Analysis	383	–	1½	–	1½
Mechanical Engineering	355	1	–	–	–
Mechanics of Materials I	105, 104	2	3	2	–
Physical Metallurgy	817, 818	2	–	2	1½
Practical Experience	10	–	–	–	–

THIRD YEAR SUBJECTS COURSE 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Equations	2432	2	–	2	–
Electronics	743, 744	2	1½	–	–
Electric Machines	747, 748	2	1½	2	3
Engineering Analysis	386	–	1½	–	3
Engineering Thermodynamics	309, 310	2	3	2	3
Fluid Mechanics	333, 334	2	–	2	3
Heat Engineering	308	2	–	1	–
Machine Design	363, 364	2	6	–	3
Practical Experience	10	–	–	–	–
Treatment of Technical Data	387	–	–	2	3
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

FOURTH YEAR SUBJECTS COURSE 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Engineering	390	1	3	2	3
Elementary Control Theory	391, 392	1	–	1	3
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Heat Engineering Laboratory	324	–	3	–	4½
Hydraulics	344, 345	2	3	2	4½
Industrial Management	396	1	–	–	–
Machine Design	373, 374	2	3	2	4½
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Structural Engineering	126, 127	2	3	–	–
Thermal Energy Conversion I	322	2	–	2	–
Thermal Energy Conversion II	323	–	–	2	–
Thesis	20	–	1	–	1

INDUSTRIAL ENGINEERING

(Course 4)

The modern view of Industrial Engineering is that of a field concerned essentially with the analysis, design, improvement and operation of integrated systems of men, materials and equipment. This new concept crystallized when it became clear that certain modern technical fields, including operations research, control theory, computer science, and probability and statistics, constituted a body of knowledge particularly useful in the operation and management of modern business, industry and government.

As a logical outcome of this development, the course in Industrial Engineering was established in 1958 to provide graduates in engineering specializing in the theory and practice of these subjects. This specialization rests upon a substantial foundation in science and mathematics, in fundamental engineering disciplines including fluid mechanics, applied thermodynamics, electrical science, mechanics of materials and machine design, and in such subjects as economics, organizational structure, financial control and industrial psychology.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION A, see page 37.

Second Year Subjects Course 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Alternating-Current Circuits	717, 718	–	–	2	1½
Calculus	2420	2	–	2	–
Dynamics	350	–	–	2	–
Economics	2720	2	–	2	–
Electricity	714, 713	2	3	–	–
Engineering Chemistry	607	2	–	–	–
Mathematical Analysis	383	–	1½	–	1½
Mechanical Design	359, 360	1	6	1	6
Mechanics of Materials	102, 104	2	3	2	–
Practical Experience	10	–	–	–	–
Probability and Statistics	2423, 2424	2	2	2	2
Physical Metallurgy	817, 818	2	–	2	1½

Third Year Subjects Course 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Accounting	2734	2	–	2	–
Differential Equations	2432	2	–	2	–
Electronics	743, 744	2	1½	–	–
Engineering Data Processing	3333, 3334	1	1½	1	1½
Fluid Mechanics	337, 338	2	3	–	–
Engineering Thermodynamics	311, 312	–	–	2	3
Industrial Management	3030, 3031	2	3	2	3
Numerical Analysis	2433, 2434	2	3	2	3
Probability and Statistics	2430, 2431	1	1½	1	1½
Practical Experience	10	–	–	–	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Current Developments in Industrial Engineering	409, 410	–	–	2	2
Dynamics of Industrial Systems	405, 406	2	3	–	–
Elementary Control Theory	407, 408	2	3	2	3
Electric Machines	760, 761	2	3	–	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Industrial Engineering Seminar	411	–	–	–	2
Industrial Psychology	2840	–	–	2	–
Machine Design	375, 376	2	3	2	3
Operations Research I	401, 402	2	3	2	3
Operations Research II	403, 404	–	–	2	3
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Thesis	20	–	2	–	2

ENGINEERING SCIENCE

(Course 5)

The Course in "Engineering Physics" was established in 1934 "to afford a training in mathematics and physics beyond that which it is possible to give in the other undergraduate courses in engineering". Originally the options offered in the Third and Fourth Years were related to the physical sciences and the name of the course, Engineering Physics, was appropriate.

In 1958 a Chemical Option was added on the same basis, i.e. in Third and Fourth Years.

In the session 1962–63 the scope of the course was broadened to include, more adequately than in the past, options related to the chemical sciences. The name of the course therefore was changed to "Engineering Science" commencing with the class graduating in 1965.

The purpose of the course is not changed. It is designed for those, who, having a definite flair for mathematics and science, anticipate proceeding to post-graduate study and an occupation in the fields research and development or teaching.

In the Second Year the student may select one of two programmes, differing by about 4 hours per week, which provide slightly greater emphasis either on the physical or the chemical sciences.

The options offered in the Third and Fourth Years cater to a variety of specific interests and prepare the student for post-graduate work in many of the Engineering Departments or in Physics, Biophysics or Applied Mathematics.

Admission to this course is granted only to those students who, having met the general admission requirements set forth on page 24 of this Calendar, obtain an average of 70% on the nine specified papers of Grade XIII, or the equivalent in other school systems.

Promotion to the Second Year of the Engineering Science course is granted only to those students who, in addition to meeting the regular requirements, obtain a weighted average of not less than 66% on the examinations of the First Year. Students who obtain a weighted average of 60% or over in the First Year of this course, and who have met all the regular requirements, will be permitted to proceed to the Second Year of any course in the Faculty, other than Engineering Science, without condition. Permission to repeat the First Year of the course in Engineering Science must be sought by petition to the Council of the Faculty.

The subjects of instruction are shown in the following tables and are more fully described according to subject reference numbers, page 69 to 136.

For FIRST YEAR CURRICULUM—DIVISION C, see page 38.

Students are required to state at the beginning of the Second Year which elective they intend to choose, and at the beginning of the Third Year which option they intend to pursue. Council retains the right to withhold an option if the number of students offering or conditions existing at the time render it impracticable to give the work.

Second Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Calculus	2425	2	–	2	–
Economics	2720	2	–	2	–
Electric Circuits	715, 716	2	1½	2	1½
Integral Calculus	2426	2	–	2	–
Mathematical Problems and Machine Computation	2428	–	3	–	3
Physical Chemistry	608, 609	2	1½	2	1½
Physics	2521, 2522	3	3	3	3
Probability and Statistics	2427	2	–	2	–
*And either of the following groups of subjects:**					
Dynamics	351	2	–	–	–
Mechanics of Materials	103, 104	–	–	2	3
or					
Inorganic Chemistry	2621	2	–	2	–
Chemical Engineering Science Laboratory	610	–	–	–	3

*It should be noted that Dynamics and Mechanics of Materials are desirable preliminary subjects for those taking Advanced Mechanics, Mechanics of Solids and Structures, or Applied Elasticity, in the Third Year.

N.B. The Thermodynamics and Nuclear options, previously offered separately, are being combined into a single option, Nuclear and Thermal Power, beginning in the Third Year in the Session 1965–66.

Third Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Differential Equations	2438	2	–	2	–
Electronics	739, 738	2	–	2	3
Mechanics of Structures	1034, 1035	2	3	2	1½
Fluid Mechanics	1028, 1029	2	1½	1	3
Physics Laboratory	2532	–	3	–	3
Thermodynamics and Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5c, Chemical					
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Atomic and Molecular Structure	2631	2	–	2	–
Chem. Eng. Thermodynamics	640	2	–	2	–
Chem. Eng. Rate Processes	641	2	–	2	–
Fluid Mechanics	339, 340	2	3	2	3
Numerical Methods	2436	2	–	2	–
Chem. Eng. Problems and Lab.	642	–	9	–	7½
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5e, Electrical					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Circuit Analysis	742	2	–	2	–
Differential Equations	2438	2	–	2	–
Electronics	739, 738	2	–	2	3
Physics of Metals	819	–	–	2	–
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	2	–	–	–
Thermodynamics and Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–

Third Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5g, Geophysics					
Advanced Mechanics	1030	2	–	2	–
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Geology	2900	2	–	2	–
Mineralogy	2910, 2911	2	3	2	3
Physics Laboratory	2532	–	3	–	3
Physics of the Earth	2536	2	–	2	–
Thermodynamics and Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5m, Materials Science					
Advanced Mechanics	1030	2	–	2	–
Atomic and Molecular Structure	2631	2	–	2	–
Chemistry of Metals	802, 829	1	–	1	4
Differential Equations	2438	2	–	2	–
Metallurgical Thermodynamics	830, 831	1	2	1	2
Physics and Chemistry of Materials	832	2	–	2	–
Physics of Metals	821, 822	2	6	2	3
Physics of Solids and Fluids	2534	1	–	1	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5nt, Nuclear and Thermal Power					
Advanced Mechanics	1030	2	–	2	–
Applied Elasticity	365, 366	1	3	1	3
Atomic and Nuclear Physics	2535	2	–	2	–
Differential Equations	2438	2	–	2	–

THIRD YEAR SUBJECTS COURSE 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Fluid Mechanics	339, 340	2	3	2	3
Heat Engineering	313, 314	1	3	1	3
Physics Laboratory	2532	–	3	–	3
Thermodynamics and Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				
Option 5p, Physics					
Advanced Mechanics	1030	2	–	2	–
Applied Elasticity	365, 366	1	3	1	3
Atomic Structure and Quantum Physics	2533	2	–	2	–
Crystallography	2916	1	–	1	–
Differential Equations	2438	2	–	2	–
Electronics	739, 738	2	–	2	3
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Thermodynamics and Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Aerodynamics	1040, 1041	2	–	2	3
Atomic Physics	2546	3	–	3	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
Engineering Design	1042, 1043	1	3	2	3
English	2140	1	–	1	–
Gasdynamics	1048, 1049	2	1½	1	3
Mechanics of Solids and Structures	1044, 1045	1	3	1	–
Philosophy of Science	2040	2	–	–	–
Plasmadynamics	1046, 1047	1	–	2	1½
Thesis	20	–	–	–	–
Transport Phenomena	1050	1	–	1	–
Option 5c, Chemical					
Chem. Eng. Design	666	2	6	2	6
Chem. Eng. Laboratory	652	–	9	–	–
Chem. Eng. Thermodynamics and Kinetics	665	3	–	3	–
English	2140	1	–	1	–
Instrumental Methods	663	–	–	2	–
Mass Transfer	650	2	–	2	–
Organic Chemistry	660, 661	2	–	1	6
Philosophy of Science	2040	2	–	–	–
Physics of Metals	816	1	–	1	–
Process Dynamics	664	2	–	2	3
Thesis	20	–	–	–	–
Option 5e, Electrical					
Acoustics	790, 791	1	–	1	1½
Communication Systems	770, 771	–	–	3	3
Control Systems	766, 767	2	1½	2	1½
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electric Machines	745, 746	2	1½	2	1½
Electromagnetic Theory, Applied	773	2	–	2	1½
Electronic Circuits	768, 769	3	3	–	–
English	2140	1	–	1	–
Logic Circuits	782	–	–	2	–
Operational Methods	772	2	–	2	–
Philosophy of Science	2040	2	–	–	–

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Thesis	20	–	–	–	–
Option 5g, Geophysics					
Atomic Physics	2546	3	–	3	
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electromagnetic Theory, Applied	773	2	–	2	1½
English	2140	1	–	1	–
Geophysical Methods	2561, 2562	2	6	2	6
Mineral Deposits	2960	2	–	2	–
Petroleum Geology	2964, 2965	2	–	2	3
Philosophy of Science	2040	2	–	–	–
Precambrian Geology	2944, 2945	2	1	–	–
Thesis	20	–	–	–	–
Option 5m, Materials Science					
Atomic Physics	2546	3	–	3	–
Chemistry of Metals	805	2	–	2	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
English	2140	1	–	1	–
Philosophy of Science	2040	2	–	–	–
Physics and Chemistry of Materials Laboratory	827	–	12	–	12
Physics and Chemistry of Materials Seminar	826	–	3	–	3
Physics of Metals	823, 824	2	3	2	3
X-Ray Crystallography	2918	–	–	2	–
Thesis	20	–	–	–	–
Option 5nt, Nuclear and Thermal Power (commencing in the Session 1966–67)					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Control Systems	398, 399	1	–	2	3
English	2140	1	–	1	–
Heat Transfer	328	–	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Nuclear Engineering	670, 671	2	3	2	3

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Operational Methods	772	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	3	–	3
Thermal Energy Conversion	331, 332	3	3	3	3
Computational Methods	393	1	3	–	–
Thesis	20	–	–	–	–
Option 5n, Nuclear (Session 1965–66 only)					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Control Systems	766, 767	2	1½	2	1½
Electromagnetic Theory, Applied	773	2	–	2	–
English	2140	1	–	1	–
Heat Transfer	328	–	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Nuclear Engineering	670, 671	2	3	2	3
Operational Methods	772	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics of Metals	816	1	–	1	–
Physics Laboratory	2542	–	6	–	3
Thesis	20	–	–	–	–
Option 5p, Physics					
Electronic Circuits	768, 769	3	3	–	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electromagnetic Radiation and Matter	2541	2	–	2	–
Electromagnetic Theory, Applied	773	2	–	2	–
English	2140	1	–	1	–
Molecular Physics and Statistical Mechanics	2543	2	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	6	–	6
Quantum Mechanics	2545	2	–	2	–
Thesis	20	–	–	–	–

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5t, Thermodynamics (Session 1965–66 only)					
Atomic Physics	2546	3	–	3	–
Computational Methods	393	1	3	–	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
English	2140	1	–	1	–
Gasdynamics	1048, 1049	2	1½	1	3
Heat Engineering Laboratory	329	–	3	–	3
Heat Power Engineering	326	1	–	1	–
Heat Transfer	328	–	–	2	–
Refrigeration and Air Conditioning	325	2	–	–	–
Internal Combustion	327	1	–	1	–
Machine Design	377	–	–	2	–
Operational Methods	772	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Thesis	20	–	–	–	–
Vibration Engineering	798, 799	1	–	1	3

CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

(Course 6)

The chemical engineer is concerned with the development and operation of processes by means of which matter is chemically altered to a more useful form, and in the design, construction, operation and management of plant in which to effect such changes. Apart from such obviously chemical processes as those concerned with the production of acids, alkalis, salts, petroleum, rubber products, pulp and paper, explosives, paints and varnishes, soap, plastics, etc., there are many industrial processes where chemistry plays a part, or where a knowledge of chemistry is valuable. There is thus a wide field of endeavour for the chemical engineer. In order to equip a student to enter this field, the course in chemical engineering is intended to provide the student with training in the principles of the major divisions of chemistry and chemical engineering, together with an understanding of such other engineering subjects as thermodynamics, hydraulics, electricity, mechanics of materials, and machine design.

As part of the work of the Fourth Year each student is assigned a problem involving original investigation, in order to let him apply to some extent what he has learned, and to introduce him to the chemical literature. It also serves as an introduction to research for those who are attracted to it, and who, because of their basic training are equipped to carry on research in chemistry or chemical engineering at the graduate level or in laboratories outside the university.

For those students considering taking up the teaching of science as a profession, the nature and extent of the thesis subject in the Fourth Year may be modified to allow the student to take such other instruction as may be necessary to shorten the time required before becoming professionally qualified.

The subjects of instruction are shown in the following tables. In these tables reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION A, see page 37.

Second Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	615, 614	2	9	–	–
Analytical Chemistry Laboratory	613	–	–	–	–
Calculus	2420, 144	2	1½	2	1½
Chemical Engineering Science Laboratory	619	–	–	–	7
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Industrial Chemistry	616	2	–	1	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	102	2	–	2	–
Organic Chemistry	618	1	–	2	–
Physical Chemistry	2622	2	–	2	–
Process Calculations	620	–	–	–	3½
Practical Experience	10	–	–	–	–

Third Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	633	1	1	1	1
Chemical Engineering Thermodynamics	640	2	–	2	–
Chemical Laboratory	627	–	6	–	6
Chemical Theory A	625	1	–	1	–
Fluid Mechanics	337, 338	2	3	–	–
Engineering Thermodynamics	315, 316	2	–	–	3
Industrial Chemistry	630	–	–	3	–
Introduction to Mass and Heat Transfer	631	2	–	2	3
Organic Chemistry	628, 629	2	9	2	6
Practical Experience	10	–	–	–	–
Public Speaking	632	–	1	–	1
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Chemical Engineering	653	–	3	–	–
Chemical Engineering Thermodynamics and Kinetics	655	2	–	2	–
Chemical Engineering Laboratory	652	–	9	–	–
Chemical Plant Design	651	1	3	1	3
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Industrial Management	396	1	–	–	–
Machine Design	378	2	–	–	–
Mass Transfer Operations	650	2	–	2	–
Organic Chemistry	654	1	–	1	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Thesis	20	–	1	–	18

ELECTRICAL ENGINEERING

(Course 7)

Although electrical engineering, which includes the field of electronics, is concerned with a vast range of electrical phenomena characterized by power in microwatts at one extreme to power in megawatts at the other, and by frequencies in thousands of megacycles per second down to zero, the same fundamental principles underlie the whole range. It is the objective of the Electrical Engineering course to lay a sound scientific foundation for any of the particular areas which the student may eventually enter. Since a thorough grounding in the basic sciences is important, a large portion of the curriculum is devoted to such subjects as Mathematics, Mechanics, Chemistry and basic Electricity and Magnetism. Stress is laid on the calculation of circuits and fields, and on the fundamentals of electronics.

The application of electrical laws and phenomena to engineering practice is dealt with in a number of subjects such as Communication Systems, Feedback Control Systems, Power Systems, Microwave Engineering and Electric Machinery. In common with the other engineering courses, subjects in allied fields are included in the curriculum; for example, thermodynamics and physical metallurgy. Also, in recognition of the fact that the successful engineer frequently assumes an administrative or executive position, the curriculum includes some subjects, such as Economics, which serve to broaden the student's viewpoint beyond the strictly technical field.

Because so much fundamental material must be covered in the undergraduate curriculum, specialization is reserved for the post-graduate years when the student may pursue intensive studies in areas such as feedback control systems, energy conversion, high-voltage phenomena, feedback control systems, energy conversion, microwaves, plasmas, radio astronomy, and bio-medical electronics.

The electrical engineer must treat the phenomena he encounters largely by mathematical analysis. It is important, therefore, that the student possess a natural aptitude for mathematics as well as qualities of imagination and abstract reasoning.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION A, see page 37.

Second Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	2623	2	–	–	–
Calculus and Differential Equations	2421	2	2	2	2
Dynamics	352, 353	2	1½	1	1½
Economics	2720	2	–	2	–
Electric Circuits I	710	3	2	3	2
Electric and Magnetic Fields	711	2		2	
Electrical Measurements	712	–	–	2	–
Electrical Laboratory	713	–	3	–	3
Mechanics of Materials	106, 104	2	3	1	–
Physics—Heat and Optics	2526	–	–	2	3
Practical Experience	10	–	–	–	–

Third Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	732	2	2	2	2
Electric Circuits II	733	3	–	3	–
Electric Machinery I	734	2	–	1	–
Electronics	737	2	–	3	–
Electrical Problems	736	–	4	–	4
Electrical Laboratory	735	–	3	–	3
Electronics Laboratory	738	–	–	–	3
Heat Engineering Laboratory	318	–	3	–	–
Machine Design	367, 368	2	3	–	–
Physics of Metal	819, 820	–	–	2	1½
Practical Experience	10	–	–	–	–
Thermodynamics	317	2	–	1	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Electronic Circuits	768, 769	3	3	–	–
Electric Machinery II	763, 764	3	3	–	–
Computer Logic and Design	781	1	–	1	–
Control Systems	765, 767	2	1½	2	1½
Electromagnetic Engineering	762	2	1	2	1
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Fluid Mechanics	346, 347	1	–	2	3
Industrial Management	396	1	–	–	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Thesis	20	–	1	–	1
And one subject from each of Groups A, B, and C.					
Group A					
Communication Systems	770, 771	–	–	3	3
Electric Power Systems	779, 780	–	–	3	3
Group B					
Microwave Engineering	776, 777	–	–	2	1½
Electric Machinery III	774, 775	–	–	2	1½
Group C					
Acoustics	792, 793	–	–	2	1½
Illumination	794, 795	–	–	2	1½

METALLURGY AND MATERIALS SCIENCE

(Course 8)

"Metallurgy and Materials Science" is the study of the production, structure, and properties of the engineering materials used in structures, machines and devices.

Modern technology makes increasingly severe demands upon both metallic and non-metallic solids; in fact, it is difficult to think of an engineering project whose basic limitations do not reside in the materials which are available. For example, aerospace travel requires materials

capable of withstanding extremes of heat, cold and pressure; the utilization of nuclear energy is limited only by materials which can withstand the effects of radiation and high neutron flux, while the transistor and the computer depend upon materials having special electrical and magnetic properties. As industry expands, the metallurgist or materials engineer will be called upon to play an increasingly important role in the economy.

The course is designed to place primary emphasis upon the fundamental principles which underly the chemical, physical and mechanical properties of solids. In the fourth year, each student is assigned an experimental problem involving original work and, where possible, this is related to the actual research in progress in the department. The student is, therefore, introduced to the methods of research.

The department is equipped with the most modern facilities for the study of the structure of materials, including X-ray diffractions, electron beam microprobe, optical equipment, together with facilities for producing and measuring high temperatures, high vacuum furnaces, etc.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION A, see page 37.

Second Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	2624	–	3	–	3
Calculus	2420	2	–	2	–
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Inorganic Chemistry	617	1	–	2	–
Materials Processing I	801, 811	1	–	2	3
Mathematical Analysis	383	–	1½	–	1½
Mechanics of Materials	105, 104	2	–	2	3
Physical Chemistry	2622	2	–	2	–
Physical Principles of Heat and Optics	2525	2	3	–	–
Probability and Statistics	2423, 2424	2	2	2	2

THIRD YEAR SUBJECTS COURSE 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry and Physics of Materials	832	2	–	2	–
Chemistry of Metals	802, 803	1	3	1	6
Crystallography	2916	1	–	1	–
Differential Equations	2432	2	–	2	–
Engineering Data Processing	3331, 3332	–	–	2	3
Materials Processing II	833	2	–	–	–
Physics of Metals	821, 822	2	6	2	3
Thermodynamics in Metallurgy	810, 812	2	4	2	4
And one of: Modern World History / Political Science	2330	2	–	2	–

FOURTH YEAR SUBJECTS COURSE 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry of Metals	805, 806	2	6	2	–
Chemistry and Physics of Materials Seminar	826	–	3	–	3
English	2140	1	–	1	–
Fluid Mechanics	348	–	–	2	1½
Heat Transfer	330	2	–	–	–
Philosophy of Science	2040	2	–	–	–
Physics of Metals	823, 824	2	3	2	3
Thermodynamics in Metallurgy	813, 814	2	2	2	2
Thesis	20	–	6	–	9

GEOLOGICAL ENGINEERING

(Course 9)

Geology is the science that treats of the earth. It investigates the origin of the earth, the forces that cause changes in the crust, and the origin, composition and economic use of rocks and minerals and their relations to one another. It deals with the structure and stratigraphic succession of rocks and their topographic expression at the earth's surface. It seeks to understand the evolution of life through study of fossil remains.

Geology spans a wide range of sciences and requires a thorough grounding in mathematics and the basic science and engineering disciplines to aid in a proper understanding of the subject and its many applications.

The first three years of the course in Geological Engineering provide a broad education in the fundamentals of geology and its associated disciplines. In the fourth year the course concentrates on the study of Economic Geology—the application of principles and methods of geology in the discovery, examination, evaluation, and production of economically useful minerals. It permits an emphasis in the last two years, on either Mining or Exploration Geophysics.

Graduation from this course leads to employment in mineral and petroleum exploration and development. Graduates are prepared for advanced study towards the M.A.Sc. and Ph.D. degrees in a number of branches of geology including Economic Geology, Geochemistry, Structural Geology and Applied Geophysics.

The subjects of instruction are shown in the following tables. The subject numbers refer to detailed descriptions in the succeeding pages, e.g., Economics, 2720, page 130.

For FIRST YEAR CURRICULUM—DIVISION B, see page 37.

Second Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
A.C. Circuits	717, 718	2	1½	–	–
Calculus	2420, 144	2	1½	2	1½
Economics	2720	2	–	2	–
Geology	2900, 2901	2	3	2	3
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	106, 104	2	–	1	1½
Mineralogy	2910, 2911	2	3	2	3
Mining	221	1	–	1	2
Optical Mineralogy	2912	–	2	–	2
Physical Chemistry	2622	2	–	2	–
Surveying	155	1	–	2	–
Practical Experience	10	–	–	–	–

Third Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Assaying	201, 202	1	3	1	3
Descriptive Mineralogy	2913	–	2	–	2
Elementary Geochemistry	2924	2	–	2	–
Geological Field Work	2983	–	–	–	–
Metallurgy	804	–	–	1	–
Mineral Dressing	246	2	–	–	–
Mining	222	1	–	2	–
Ore Microscopy	2915	–	–	–	3
Palaeontology	2938, 2939	2	2	2	2
Petrology	2920, 2921	3	2	2	2
Practical Experience	10	–	–	–	–
Stratigraphy and Sedimentation	2932, 2981	2	2	–	–
Structural Geology	2950, 2951	1	3	1	3
Survey Camp	158	–	–	–	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
English	2140	1	–	1	–
Geology of Canada	2904	1	–	1	–
Geological Field Trips	2985, 2987	–	–	–	–
Geophysics	2568, 2569	1	3	1	3
Metallurgy	808	1	–	1	–
Mineral Deposits	2960, 2961	2	–	2	3
Mine Operation and Administration	224, 226	2	–	2	3
Mining Geology	2968, 2969	–	3	2	–
Petroleum Geology	2964, 2965	2	–	2	3
Pleistocene Geology	2936	2	–	2	–
Practical Experience	10	–	–	–	–
Precambrian Geology	2944, 2945	2	3	–	3
Philosophy of Science	2040	2	–	–	–
Thesis	20	–	6	–	–

AEROSPACE SCIENCE AND ENGINEERING

A five-year program of study is offered to prepare the student for a career in the aerospace field. It includes the following elements: (*a*) an introduction to the fundamentals of mathematics, physics, and chemistry, (*b*) an introduction to aerodynamics, instrumentation, propulsion, structures and design, and (*c*) an advanced treatment of the subjects required for modern design and research in aerospace science and engineering such as hypersonic aerodynamics, flight dynamics, and space propulsion. Under (*a*) and (*b*) the student's training is necessarily broad and basic. The more advanced knowledge needed for the research, development, and design relevant to new aircraft and spacecraft is provided under (*c*) and is of particular significance. Parts (*a*) and (*b*) are provided in a four-year undergraduate course, but the final intensive training under (*c*) is left for a postgraduate (fifth) year.

The program of study that leads to status as a well-qualified aerospace engineer has been established in two parts as follows:

(i) *Undergraduate Course.* The student registers in the course in Engineering Science, subject to the entrance requirements given on page 24 of this Calendar. This course provides the requisite training in the fundamental sciences (see (*a*) above). The advanced subjects contained in the Aerospace option given in the third and fourth years are taught by the staff of the Institute for Aerospace Studies (see (*b*) above). The student will receive the degree of Bachelor of Applied Science upon completion of this part of the program.

(ii) *Graduate Course.* The student will then continue his five-year program (see (*c*) above) in the Institute for Aerospace Studies, as a candidate for the degree of Master of Applied Science. Details regarding entrance regulations and courses of study are given in the Calendar of the School of Graduate Studies. The facilities of the Institute are available to the student. For details of research projects, assistantships, scholarships and demonstratorships, students should consult the Annual Bulletin of the Institute.

It should be noted that a student who has graduated in another branch of engineering and who desires to qualify as an aerospace engineer may proceed directly with (ii) above, but in this case the course leading to the M.A.Sc. degree must be arranged so that deficiencies in his undergraduate training are made up.

The facilities of the Institute are available for further graduate study leading to the Ph.D. Degree.

OUTLINE OF LECTURE AND LABORATORY SUBJECTS

On the pages that follow a brief description is given of the lectures and laboratory subjects prescribed in the preceding tables of curriculum. The numbers before the subjects are the reference numbers assigned in the tables. For example, 135, Descriptive Geometry, means the course of lectures indicated by this number in the table of curriculum for the First Year on page 37.

Where laboratory reports are to be written outside of assigned laboratory hours the maximum number of such reports is indicated in the description of the laboratory course concerned.

FACULTY REQUIREMENTS

10. Practical Experience.

Students in the courses listed below are required to have, before graduation, practical work of a nature acceptable to the department concerned. This may be obtained during the summer vacations but work done before entering the Faculty may also meet the requirements. Instructions will be issued by the departments concerning the type of work which is acceptable. Practical experience certificate forms may be obtained from the departments and should be retourned there when completed.

Course 1	600 hours
Course 2	800 hours
Course 3	600 hours
Course 4	600 hours
Course 6	600 hours
Course 7	600 hours
Course 8	600 hours
Course 9	600 hours

20. Thesis

All courses, IV Year.

Every student in the Fourth Year is required to prepare a thesis on a approved subject. Instructions will be issued by the departments concerned.

In some cases written presentation is required, in others oral and written, or it may consist of a research problem followed by a written thesis or report.

DEPARTMENT OF CIVIL ENGINEERING

100. Applied Mechanics. Staff in Civil Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

This subject is divided into two parts, statics and dynamics.

Statics: The principles of statics are discussed, and applied to the composition and resolution of forces. A variety of applications are studied, including plane pin-jointed frames and simple three-dimensional structures.

Dynamics: Theoretical principles and practical applications are discussed for:

Particle motion on straight and curved paths; work energy and power; impulse and momentum; plane translation and rotation of rigid bodies.

Textbook: *Engineering Mechanics*—Higdon and Stiles (Second Edition).

101. Statics. R. A. Collins, J. Schwaighofer.

Course 5, I Year; 2 hrs. lectures per week, first term.

Translational and rotational resultants and equilibrants are discussed together with equivalent force systems in two- and three-dimensional space. Emphasis is placed on systems in equilibrium. A variety of applications is studied including frameworks, simple machines, and bending moments and shearing forces in beams.

Textbook: *Mechanics for Engineers: Statics*—Beer & Johnston (Second Edition).

102. Mechanics of Materials. K. Meipoom, K. A. Selby, R. G. Tress.

Courses 4 and 6, II Year; 2 hrs. lectures per week, both terms.

In this subject, the fundamental theories of stress and strain are investigated as they apply to the selection of adequately proportioned materials to carry a given load in such engineering applications as tension, compression, torsional, and other members.

Textbook: *Mechanics of Materials*—Higdon, Ohlsen and Stiles.

103. Mechanics of Materials. R. A. Collins.

Course 5, II Year (elective); 2 hrs. lectures per week, second term.

Basic relationships between force, stress, strain, and deflection of bodies made of various engineering materials are discussed. Beams, columns, shafts, tension members and pressure vessels are analysed and designed for strength and stiffness.

Textbook: *Mechanics of Materials*—Popov.

104. Mechanics of Materials Laboratory: General. J. D. Barker, C. E. Helwig, C. W. Dillane, K. Meipoom, R. G. Tress.

Courses 1, 2, and 8, II Year; 3 hrs. laboratory per week, second term.

Course 5, II Year (elective); 3 hrs. laboratory per week, second term.

Courses 3, 4, 7, II Year; 3 hrs. laboratory per week, first term.

Course 9, II Year; 3 hrs. laboratory, alternate weeks, second term.

An introduction to testing machines, strain and other measuring devices and standard specifications.

The experimental study of some engineering materials and structural members under applied load.

No laboratory report shall be written outside the assigned teaching hours.

105. Mechanics of Materials. J. D. Barber, S. M. Uzumeri.

Courses 1, 2, 3, 8 and 9, II Year; 2 hrs. lectures per week, both terms.

An introduction to the elastic and inelastic behaviour of solids under various external loading conditions. Strains, stresses and

deformations are determined for members subjected to tension, compression, torsion and bending and for pressure vessels by using basic strength of materials theories.

Textbook: *Mechanics of Materials*—Popov.

106. Mechanics of Materials. A. C. Davidson.

Course 7, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

The fundamental relations among stress, strain and applied load are worked out for tension, compression, twisting and bending in the elastic and inelastic ranges, for various engineering materials. Buckling phenomena are examined for struts and columns. Numerical applications are done in lectures; and problems are assigned for study.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Snyder.

110. Mechanics of Materials II. C. Helwig, J. Schwaighofer.

Course 1, Group A, III Year; 2 hrs. lectures per week, both terms.

Cement and concrete technology; an introduction to the design of reinforced concrete members; behaviour of metals; special topics on bending of beams; failure theories; introduction to experimental stress analysis. Problems and laboratory under Course 113.

Textbooks: *Reinforced Concrete Fundamentals*—Ferguson; Concrete Manual by U.S. Bureau of Reclamation. *Mechanics of Materials*—Popov.

Reference book: *Concrete Technology I & II*—D. R. Orchard.

111. Structural Design. M. W. Huggins.

Course 1, Group A, III Year; 2 hrs. lectures per week, both terms.

An elementary study of the stress analysis and design of structures, structural members, and their details.

The work covered includes steel and timber tension members, compression members and flexural members, including box girders and plate girders and continuous as well as simple span beams. Welding, riveting and high tension bolting, as methods of connecting structural members, are studied. Design and analysis problems under Course 113.

Textbook: *Design of Steel Structures*—Gaylord and Gaylord.

Reference books: *Structural Problems*—Young and Morrison. *Plastic Design of Steel Frames*—Beedle.

112. Structural Theory I. C. F. Morrison.

Course 1. Group A, III Year; 3 hrs. lectures per week, second term.

The stress analysis of simple span, continuous and cantilever trusses. Influence lines and index stresses. Truss deflections by

analytical and graphical methods. Analysis of statically indeterminate trusses, beams and frames by various methods.

Problems under Course 113.

Textbook: *Structural Theory*—Sutherland and Bowman.

113. Structural Laboratory. Staff in Civil Engineering.

Course 1, Group A, III Year; 7½ hrs. per week, first term, 6 hours per week, second term.

Problems and laboratory to complement subjects 110 and 112.

Study periods of design and analysis to complement subject 111; during the fall term two timber structures and during the spring term one steel structure are designed. The designs are discussed and evaluated.

Three hours per week of the above time in the first term will be devoted to the cements and concrete laboratory; the balance will be on problems and design.

114. Structural Engineering I. G. T. Will.

Course 1, Group B, III Year; 2 hrs. lectures per week, both terms.

An introduction to the analysis and design of structures, structural members and their details.

The work covered includes steel and timber columns, tension members and connections.

Problems under Course 115.

Textbooks: *Design of Steel Structures*—Gaylord & Gaylord. C.I.S.C. Steel Construction Series—Book Two. *National Building Code of Canada.*

Reference book: *Elementary Structural Analysis*—Norris and Wilbur.

115. Structural Laboratory. G. T. Will.

Course 1, Group B, III Year; 3 hrs. alternate weeks in first term, and 3 hrs. per week, second term.

Design and analysis problems to complement subject 114.

116. Reinforced Concrete I. S. M. Uzumeri.

Courses IA, 1C and 1D, IV Year; 2 hrs. lectures per week, both terms.

Ultimate and working strength behaviour of Reinforced Concrete members subjected to flexure, axial compression, shear, combined axial compression and flexure, combined flexure and shear, and bond.

Relation between research results and current specifications for design of members.

Design of simple and continuous beams, one way, two way and flat slabs, columns, retaining walls and footings.

Problems under course 120 for course 1A. Problems under course 121 for courses 1C and 1D.

Reference books: *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

117. Reinforced Concrete II. M. W. Huggins.

Course 1A, IV Year; 2 hrs. per week, both terms.

Ultimate design; prestressed concrete; composite design; design of building frames, arches and bridges. Behaviour of reinforced concrete members.

Problems under Course 120.

Reference books: *Theory & Practice of Reinforced Concrete*—Dunham. *Reinforced Concrete Design*—Sutherland and Reese. *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

118. Behaviour and Design of Steel Structures. D. J. L. Kennedy.

Course 1A, IV Year; 2 hrs. per week, both terms.

A continuation of Course 111. The behaviour of structural elements and structures is discussed and related to design methods and criteria. Topics include, repeated loading, brittle fracture, welding, connections, buckling, inelastic behaviour, analysis and design of metal structures by ultimate load procedures.

Problems under Course 120.

Textbooks: *Structural Steel Design*—Beedle *et al. Canadian Institute of Steel Construction*—Steel Construction Series, Books 1, 2, 3.

119. Structural Theory II. G. Kani, R. A. Collins.

Course 1A, IV Year; 2 hrs. per week, first term, 3 hrs. per week, second term.

Analysis of statically indeterminate structures; influence lines for statically indeterminate structures; the use of strain energy, slope deflection, moment distribution, column analogy and Kani methods; an introduction to plates and shells.

Problems under Course 120.

120. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.

Course 1A, IV Year; 12 hrs. per week, first term and 10 hrs. per week, second term.

Project, problems and Mechanics of Materials laboratory to supplement courses 116, 117, 118, 119 and 140.

121. Structural Laboratory. Staff in Civil Engineering.

Courses 1C and 1D, IV Year; 3 hrs. per week, both terms.

Design and analysis problems, and testing laboratory to supplement course 116.

122. Structural Engineering II. C. E. Helwig.

Course 1B, IV Year; 2 hrs. per week, both terms.

Cements and concrete; design and analysis of reinforced concrete members; design of steel structures as an extension to course 114. Problems and concrete laboratory under course 123.

Textbooks: *Reinforced Concrete Fundamentals*—Ferguson. *Design of Steel Structures*—Gaylord & Gaylord.

123. Structural Laboratory. C. E. Helwig.

Course 1B, IV Year; 4½ hrs. per week, first term and 3 hrs. per week, second term.

Design and analysis problems to supplement course 122. In the first term 3 hours per week will be devoted to Cements and Concrete laboratory.

124. Elementary Structural Engineering. A. C. Davidson.

Course 2, III Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

The fundamental principles of Statics and Mechanics of Materials are applied to the design and analysis of structural members and their connections. Problems are worked in class and in the drafting room (Subject No. 125).

Textbooks: *Design of Steel Structures*—Gaylord & Gaylord. *Material Specifications Book One, Properties of Sections Book Two, Steel for Building, Book Three*, Canadian Institute of Steel Construction, Toronto. *National Building Code of Canada*—National Research Council, Ottawa. *Basic Reinforced Concrete Design*—Large.

125. Structural Engineering Problems. A. C. Davidson.

Course 2, III Year; 3 hrs. per week, second term.

Problems supplementing the work covered in lecture course 124 are assigned and worked out in the drafting room.

126. Structural Engineering. J. D. Barber.

Course 3, IV Year; 2 hrs. lectures per week, first term.

The fundamental principles of Statics and Mechanics of Materials are applied to the design and analysis of structural members and their connections. Problems are worked in class and in the drafting room (Subject 127).

Moving loads on simply supported beams; tension, compression and flexural member details.

Textbook: *Design of Steel Structures*—Gaylord & Gaylord.

127. Structural Engineering Problems. J. D. Barber.

Course 3, IV Year; 3 hrs. per week, first term.

Problems supplementing the work covered in lecture course 126.

130. Construction Management and Business. M. G. Tallon, S. G. Hennessey.

Course 1, IV Year; 2 hrs. lectures per week, second term.

A study of heavy and building construction, including job planning and organization, construction methods and equipment,

superintendence, job records, labour relations and safety procedures. Elements of business organization and management with an introduction to the principles of control through accounting records and financial statements.

135. Descriptive Geometry. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, G. W. Heinke, P. Wodzianski.

All courses, 1 Year; 1 hr. lecture per week, both terms.

These lectures deal with the principles of orthographic, oblique and perspective projection and their use in solving problems of straight lines, planes, and curved surfaces.

Textbook: *Descriptive Geometry*—Watts and Rule.

137. Engineering Problems and Drawing. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, G. W. Heinke, P. Wodzianski.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 6 hrs. per week, both terms.

Drawing and lettering. Problems in descriptive geometry and applied mechanics. An introduction to graphical methods of solving engineering problems, e.g., nomography, empirical equations, graphical algebra and calculus, projective geometry. Plotting of original surveys for courses 1, 2 and 9.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

138. Engineering Problems and Drawing. C. A. Wrenshall, K. A. Selby, V. P. Borecky.

Course 1, II Year; 6 hrs. per week, both terms.

Problems in descriptive and projective geometry, nomography, graphical calculus. Graphs and empirical equations. Structural drawing. Plotting of original surveys. Problems in mathematics.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

139. Engineering Mathematics Problems. G. T. Will.

Course 1, III Year; 3 hrs. per week, alternate weeks first term, 3 hrs. per week, second term.

Problems based on the content of Lecture Course 141.

140. Mathematical Applications. R. A. Collins.

Courses 1A, 1C, 1D, IV Year; 2 hrs. lecture per week, first term.

The formulation, discussion and solution of certain civil engineering problems by numerical methods, relaxation techniques, electronic computation, and other approximations.

141. Engineering Mathematics. G. T. Will.

Course 1, III Year; 2 hrs. lectures per week both terms.

An introduction to programming for the electronic computer. The solution of differential equations and their application in Civil Engineering.

Textbook: *Applied Differential Equations*—Spiegel.

142. Engineering Problems and Drawing. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky.

Course 5, I Year; 3 hrs. per week, both terms.

Drawing and lettering. Problems in descriptive geometry and applied mechanics.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

144. Mathematics Problems. K. A. Selby.

Courses 2, 6 and 9, II Year; 3 hrs. per week, alterate weeks, both terms.

Problems in mathematics.

150. Surveying. O. J. Marshall, S. G. Bird.

Courses 1 and 9, I Year; 1 hr. lecture per week, first term.

General principles and practice of surveying with the tape, the transit, and the level, and computation of corrections, azimuths, bearings, latitudes and departures, co-ordinates and areas.

Textbook: *Surveying*—Philip Kissam.

Reference books: *Elementary Surveying*—Breed, Hosmer and Bone. *Measurements for Engineering and other Surveys*—Smirnoff. *Surveying*—Breed and Bone.

151. Surveying Field Work. O. J. Marshall, B. J. Haynes, H. L. Macklin, R. C. Gunn, S. G. Bird.

Courses 1 and 9, I Year; 3 hrs. per week, first term.

Practice in chaining; keeping of field notes; the use of the transit in surveying closed figures and traverse lines; plotting by co-ordinates; computing areas; instrumental work with the level and calculating and volume of excavations.

153. Surveying. O. J. Marshall. B. J. Haynes.

Course 1, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Simple, reverse, compound and spiral curves as applied to Highway and Railroad surveying. Main features of mine and hydrographic surveying. Construction surveying dealing with cross sectioning, earthwork, quantities, mass or haul diagram, super elevation, vertical curves, and layout of roads and sewers.

Textbook: *Route Surveys*—Skelton.

154. Surveying Laboratory. O. J. Marshall, B. J. Haynes, R. C. Gunn, S. G. Bird.

Course 1, II Year; 3 hrs. per week, both terms.

First Term: Field problems, in levelling, traversing, curves and topography.

Second term: Surveying computations, including traversing, curves, astronomy, and earth work quantities.

155. Surveying. H. L. Macklin.

Courses 2 and 9, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Mine surveying, with problems related thereto. Simple curves, stadia and plane table topographical surveying. Practical determination of time, latitude and azimuth by methods adapted to the surveyor's transit.

Textbook: *Surveying for Civil Engineers*—Kissam.

156. Surveying Laboratory. H. L. Macklin, S. G. Bird.

Course 2, II Year; 3 hrs. per week, first term; 2 hrs. per week, second term.

First term: Field problems in levelling, traversing, curves and topography.

Second term: Surveying computations, including traversing, curves, astronomy, and mine surveying problems.

157. Practical Astronomy. H. L. Macklin.

Course 1, II Year; 2 hrs. lectures per week, second term.

The derivation of formulae and their application to the solution of spherical triangles and practical problems. Practical determination of time, latitude and azimuth by methods adapted to the use of the surveyor's transit. The subject will be designed to enable the student to carry out these observations at the Summer Survey Camp.

Textbook: *Practical Astronomy*—Nassau.

158. Survey Camp. Staff in Civil Engineering.

Course 1, III Year; Aug. 16 to Sept. 17—Dorset or Gull Lake; Courses 2 and 9, III Year; Aug. 23 to Sept. 17—Gull Lake.

Course 1:

(a) Secondary Triangulation and Base Line Measurements.
(b) Highway and Railway Location.
(c) Cross Sectioning and Computation of Earthwork.
(d) Stadia and Plane Table Topography.
(e) Observations for Time, Azimuth, and Latitude.

Courses 2 and 9:

(a) Stadia and Plane Table Topography.
(b) Mine Surveying, using overhead stations.
(c) Shaft plumbing and use of Auxiliary Telescope.

Students in Courses 1, 2 and 9 will be required to take the Survey Camp between the Second and Third Years; on failure to do so, this subject will be carried as a supplemental in the Third Year.

Application to defer attendance at the Camp must be made to the Secretary of the Faculty before July 15.

159. Least Squares. H. L. Macklin.

Course 1B, III Year; 3 hrs. laboratory per week, first term.

The general principles of probability of errors, elementary problems illustrating the application of Least Squares to the adjustment of observations, empirical constants and formulae.

No laboratory reports shall be written outside the assigned teaching hours.

Textbook: *Least Squares in Engineering*—Marshall and Macklin.

160. Geodetic Engineering. O. J. Marshall.
Course 1B, III Year; 2 hrs. lectures per week, second term.
Principles, equipment and methods of geodetic survey involving triangulation, traverse and levelling of high precision; elementary geodesy and map projections.

161. Geodetic Engineering Laboratory. O. J. Marshall, B. J. Haynes.
Course 1B, III Year; 3 hrs. per week, second term.
Problems and computations supplementing the work covered in subject 160.

162. Photogrammetry I. J. Vlcek.
Course 1B, III Year; 2 hrs. lectures per week, first term.
Outline of photogrammetry. Central projection. Camera: interior orientation. Stereoscopic vision and methods of viewing stereo. Terrestrial photogrammetry: geometry of stereo-pairs, stereocomparator, error analysis. Aerial photogrammetry: camera and film, photography, geometry of single picture, radial line triangulation, geometry of stereo-pairs, analysis of model deformations and parallax corrections in near vertical pictures. Simple instruments for details transfer from photo to map.

163. Photogrammetry I. Laboratory. J. Vlcek.
Course 1B, III Year; 3 hrs. per week, first term.
Laboratory work supplementing the lecture course 162.

164. Photo Interpretation. S. G. Bird.
Course 1B, III Year; 2 hrs. lectures per week, second term.
The use of aerial photographs in geology, land use, forestry, etc.; methods of extracting, and displaying the information available—all based on the use of a large collection of diversified photography.

165. Photo Interpretation Laboratory. S. G. Bird.
Course 1B, III Year; 3 hrs. per week, second term.
Laboratory work supplementing the lecture course 164.

167. Survey Camp. O. J. Marshall, H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; Aug. 23 to Sept. 17, Gull Lake.
Triangulation, trilateration, electronic distance measurements, traverses, levelling and astronomical observations by precise methods.

168. Geodetic Adjustments. R. C. Gunn.
Course 1B, IV Year; 1 hr. lecture per week, both terms.
The theory of adjustment of geodetic measurements. The adjustment of triangulation, trilateration and level nets. The variance of the observed and the adjusted quantities. Curve fitting, and the application of the electronic computer to survey problems.

169. Geodetic Adjustments Laboratory. R. C. Gunn.
Course 1B, IV Year; 3 hrs. laboratory per week, both terms.
Adjustment of observations. Solution of problems by desk calculation and electronic computer.

170. Photogrammetry II. J. Vlcek.
Course 1B, IV Year; 1 hr. lecture per week, both terms.
Review of elementary matrix theory. Theory of model restitution. Plotting instruments. Methods of instrumental aerial triangulation and its adjustments. Introduction to analytical methods of aerial triangulation.

171. Photogrammetry II. Laboratory. J. Vlcek.
Course 1B, IV Year; 3 hrs. laboratory per week, first term; 3 hrs. laboratory, alternate weeks, second term.
A laboratory course supplementing subject No. 170.

172. Astronomy. H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; 1 hr. lecture per week, first term.
Precise determination of time, latitude, longitude and azimuth as applied to geodetic surveys.

173. Astronomy Laboratory. H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; 3 hrs. laboratory per week, first term.
Observations and problems to accompany subject 172.

174. Engineering and Legal Surveys. B. J. Haynes.
Course 1B, IV Year; 2 hrs. lecture per week, first term, and 1 hr. lecture per week, second term.
Construction surveying problems dealing with prismoidal volumes and corrections, hydrographic surveying, tunnel surveying, circular curve intersections, area computations, chronological order of land subdivision and layout from early township patterns to present-day subdivisions, the weighing of survey evidence in the retracement of construction and legal surveys, and the preparation of legal surveys.

175. Geodesy and Electronic Surveying. R. C. Gunn.
Course 1B, IV Year; 2 hrs. lectures per week, both terms.
Ellipsoidal geometry, deflections of the vertical, reduction of geodetic measurements to the ellipsoid, geodetic position computations, electronic surveying, map projections.

176. Geodetic Computation Laboratory. R. C. Gunn.
Course 1B. IV Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.
Problems in geodetic computations, the reduction of electronic distance measurements, the calculation of geodetic positions, map projection co-ordinates.

180. Sanitary Engineering. A. P. Bernhart.
Course 1, III Year; 2 hrs. lectures per week, first term.

The objective of Sanitary Engineering and Pollution Control. Basic outline of problems of urbanization and the natural cycle of water. Water Purification. Treatment of domestic and industrial waste waters. Municipal Services—water mains, sanitary sewers, storm water drainage, garbage disposal. Air Pollution Control—equipment and planning considerations.

181. Air and Water Resources. A. P. Bernhart.

Course 1C, IV Year;

2 hrs. lectures per week, first term.

3 hrs. lectures per week, second term.

Water Resources: Natural cycle of water. Pollution by urban developments. Self-purification of natural water bodies. Watershed planning.

Water Purification: Screens, coagulation, sedimentation, filtration, chlorination, fluoridation, softening, iron removal, pumps.

Waste Water Treatment: Screens, grit removal, sedimentation, activated sludge process, trickling filters, chlorination, tertiary treatment, sludge digestion and dewatering. Industrial waste waters.

Air Resources: Natural air movements, micro climates. Causes, effects, history and disasters of air pollution. Aerosols and gaseous pollutants. Control by planning and cleanliness. Dust collectors, gas washers and absorbers, electro-static precipitators.

Pollution Control: As one problem of urbanization, the engineer's responsibility toward the society.

182. Municipal Engineering and Planning; Sanitary Chemistry. A. P. Bernhart, G. W. Heinke.

Course 1C, IV Year; 2 hrs. lectures per week, both terms.

Planning: Units of urban planning and their layout; aspects and implementation of planning.

Roads: Layout of systems, cross sections, construction.

Water Supply: Long distance transmission, distribution.

Sanitary and storm sewers: Systems, pumping stations, drainage.

Complete service systems for urban areas: design, administration and financing.

Analysis of Water Pollutants: Physical, chemical, biological. (Oxygen, nitrogen, carbon and iron; turbidity, hardness; microorganisms.)

183. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.

Course 1C, IV Year; 7½ hrs. per week, first term; 7 hrs. per week, second term.

Thesis project and design problems supplementing courses 140, 181, 182, 187.

Several inspection field trips and reports on Water and Wastewater Plants, Subdivision Construction, Airpollution Control Installations.

Laboratory work on standard testing methods for air and water pollution.

Several field and laboratory reports.

185. Highway Engineering. M. M. Davis.

Course 1, III Year; 2 hrs. lectures per week, first term.

Organization, administration, economics and planning of rural highways; highway materials and paving; principles of location, design, construction and maintenance.

Textbook: *Highway Engineering*—Oglesby and Hewes, 2nd Edition.

Reference books: *The Highway Improvement Act—Ontario Highway Standards and Specifications*—Department of Highways of Ontario. *Soil Mechanics for Road Engineers*—D.S.I.R.—H. M. Printer, *Policy on Geometric Design of Rural Highways*—A.A.S.H.O.

186. Municipal Planning, Administration and Transportation. M. M. Davis, H. L. Macklin, D. F. D. Pinker.

Course 1, III Year; 3 hrs. lectures per week, second term.

Contemporary concepts in town and regional planning and their theoretical, practical and legal applications as applied in Canada.

Organization of municipal government, municipal finance, legislation governing municipal operation, role of the municipal engineer and private practitioner in public works, provisions of municipal services.

Urban and regional growth as affected by transportation, trends, demands, characteristics and capacities, co-ordination with land use and integration with other services.

187. Traffic Engineering. R. M. Soberman.

Course 1C, IV Year; 2 hrs. lectures per week, second term.

Course 1D, IV Year; 2 hrs. lectures per week, first term.

Urban transportation planning, methods of project evaluation, characteristics of traffic flow, and traffic control at intersections.

Textbook: *Traffic Engineering*—Matson, Smith and Hurd.

References: *Principles and Techniques of Predicting Future Demand for Urban Area Transportation*—Martin, Memmott, and Bone. *Highway Capacity Manual.*

188. Transportation Engineering. M. M. Davis, R. M. Soberman.

Course 1D, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Transportation systems: highway, railroad, shipping, pipelines, conveyors, airports. Structural design of pavements. Theory of traffic flow.

Reference books: *Introduction to Transportation Engineering*—Hay; *Planning & Design of Airports*—Horonjeff; *Railroad Engineering*—Hay; *Soil Mechanics for Road Engineers*—D.S.I.R.;

Principles of Pavement Design—Yoder; *Poisson & Traffic*—Eno Fndn.

189. Air Photo Interpretation. S. G. Bird.
Course 1D, IV Year; 1 hr. lecture per week, first term.
Analysis and interpretation of aerial photographs for the prediction of engineering properties of soils.

191. Soil Mechanics. F. A. De Lory.
Course 1, III Year; 2 hrs. lectures per week, first term.
Identification and classification of soils for engineering purposes; weight volume relationships, compaction; permeability and drainage characteristics; consolidation; field exploration and sampling; stress-deformation characteristics; shearing strength.
Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

192. Soil Mechanics and Foundations. F. A. De Lory, E. I. Robinsky.
Course 1A, C, D, IV Year; 2 hrs. per week, first term; 1 hr. per week, second term.
Shearing strength of soils, consolidation and settlement, slope stability, bearing capacity, footings, retaining walls, braced cuts, piling, dewatering.
Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

193. Earth Structures and Foundations. F. A. De Lory, E. I. Robinsky.
Course 1D, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.
Properties of unsaturated soils, fills, embankments, earth and rockfill dams, seepage, flow nets, sheet pile bulkheads, cellular cofferdams, geotechnical processes, tunnels, underpinning.
Reference books: *Soil Mechanics in Engineering Practice*—Terzaghi and Peck; *Pile Foundations*—Chellis; Proceedings of Soil Mechanics Conferences.

195. Soil Mechanics and Highway Laboratory. F. A. De Lory, E. I. Robinsky, R. M. Soberman.
Course 1, III Year; 3 hrs. per week, first term.
A series of laboratory and problem periods to accompany courses in Soil Mechanics (191) and Highway Engineering I (185).

196. Soil Mechanics Laboratory. F. A. De Lory, E. I. Robinsky.
Courses 1A and 1C, IV Year; 2 hrs. laboratory per week, second term.
Course 1D, IV Year; 2 hrs. laboratory per week, first term.
Laboratory experiments and testing to accompany Soil Mechanics and Foundations (192).
No laboratory reports to be written outside assigned laboratory hours.

197. Air Photo Interpretation Laboratory. S. G. Bird.
Course 1D, IV Year; 3 hrs. laboratory per week, first term.
Laboratory periods to accompany Air Photo Interpretation (189).

198. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.
Course 1D, IV Year; 4 hrs. per week, first term; 9 hrs. per week, second term.
Problem and laboratory periods to accompany subjects 140, 188 and 193.

DEPARTMENT OF MINING ENGINEERING

201. Assaying. W. A. M. Hewer.
Courses 2 and 9, III Year; 1 hr. lecture per week, both terms.
Theory and practice of fire assaying. Emphasis is laid not only upon the principles of chemistry, metallurgy and sampling involved, but also upon the errors inherent in operators as well as in methods.
References: *Manual of Fire Assaying*—Fulton and Sharwood. *Textbook of Fire Assaying*—Bugbee. *Fire Assaying*—Shepherd and Dietrich. *The Sampling and Assay of the Precious Metals*—E. A. Smith.

202. Assaying Laboratory. W. A. M. Hewer.
Courses 2 and 9, III Year; 3 hrs. laboratory per week, both terms.
The determination of precious metals. Scorification, crucible and combination wet and dry methods of assaying ores both simple and complex; milling and metallurgical products including cyanide solutions, cyanide precipitates and gold bullion. Attention is also given to the sampling and assay of ores containing radio-active minerals.

203. Wet Analysis. W. A. M. Hewer.
Course 2, III Year; 3 hrs. laboratory per week, both terms.
Analysis of furnace products, base metal, and radioactive ores.

221. Mining. H. R. Rice, W. A. M. Hewer.
Courses 2 and 9, II Year; 1 hr. lecture per week, both terms, and 2 hrs. laboratory per week, second term.
A combined lecture and laboratory subject in the principles of mining and its unit processes. Emphasis is placed on the statistical approach to sampling calculations.

222. Mining. H. R. Rice.
Courses 2 and 9, IIII Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.
Methods of mine development by mine adits, shafts, drifts and crosscuts; stoping methods, loading, and underground transportation.

223. Mining Laboratory. H. R. Rice, S. E. Wolfe.

Course 2, III Year; 3 hrs. laboratory per week, first term; 2 hrs. laboratory per week, second term.

Special mining problems are given relating to sampling, diamond drilling, stope measurements, the factors affecting the behaviour of broken material. To develop the individual student's initiative, some special survey problems are worked in the laboratory.

224. Mine Operation and Administration. H. R. Rice.

Courses 2 and 9, IV Year; 2 hrs. lectures per week, both terms.

Lectures on advanced mining practice, including mining methods, ground control, mine mechanization, mine services and plant, aspects of administration and finance, and industrial relations.

225. Mining Laboratory. H. R. Rice.

Course 2, IV Year; 2 hrs. laboratory per week, first term; 6 hrs. laboratory per week, second term.

A problem which progresses from essential geological data, to a complete design of the related mine, which integrates the principles of mine economics, selection of mining rates, ore-reserve calculations, and plant design.

226. Mining Laboratory. H. R. Rice.

Course 9, IV Year; 3 hrs. laboratory per week, second term.

Problems in mine layout involving shaft location and size; mine development; choice of stoping methods, mining rate, and mine equipment; time and cost schedules; ore reserve calculations. to give the student some practice in the use of ventilation test equipment, and the solution of ventilation problems. An aggregate of about ten off-campus study hours may be required in preparation of some reports. This subject relates to subject 321.

241. Mineral Dressing. S. E. Wolfe.

Course 2, III Year; 2 hrs. lectures per week, both terms.

The subject deals with the economics of, the theoretical principles and their practical application in, the treatment of ores and mineral aggregates. These involve the processes of crushing, grinding, sizing and classification; gravity, magnetic, and electrostatic separation; and an introduction to froth flotation. In addition, ancillary processes are studied. These include flocculation, sedimentation, filtration, drying of mineral products and the precipitation and collection of dust and fume.

243. Mineral Dressing Laboratory. S. E. Wolfe.

Course 2, III Year; 6 hrs. laboratory per week, second term.

This work is coordinated with the lecture subject 241. Studies are made of crushing machinery, the principles of crushing and grading of rock products, screen analysis, and the sampling of broken material and mill products. Certain tests with gravity concentrating machines are made and an introduction to the technique of flotation test work is given.

244. Ore Dressing. S. E. Wolfe.
Course 2, IV Year; 1 hr. lecture per week, both terms.
The subjects covered are extensions of those in 241, 242, and 243; cyanidation, flotation processes and techniques, the current practice at milling plants, and problems associated with milling.

245. Ore Dressing Laboratory. S. E. Wolfe.
Course 2, IV Year; 6 continuous hours per week, first term.
Advanced work coordinated with lecture subject 244 and pertaining to ore dressing appliances, the handling in bulk of finely divided solids, the selective flotation of sulphides, ore testing, and pilot plant mill runs.

246. Mineral Dressing. S. E. Wolfe.
Course 9, III Year; 2 hrs. lectures per week, first term.
This abridged subject deals with current practice and fundamental principles in the field of mineral beneficiation.

251. Mine Ventilation Laboratory. The Staffs in Mining and Mechanical Engineering.
Course 2, IV Year; 3 hrs. laboratory per week, first term.
Experiments in the laboratories and problems in the study room

261. Summer Essay. W. A. M. Hewer.
Course 2, III Year:
An essay, or report, written on a mining topic, preferably some phase of work with which the student is associated during summer employment. Subsequently, each student will deliver a talk to his class on the topic chosen. Thus, training is afforded in both technical writing and public speaking. Students are briefed in advance concerning requirements of this subject.

275. Thesis Project, Laboratory and Seminar. The staff in Mining Engineering.
During the Fourth Year of his Course, each student is required to select an area of investigation suitable to the Department and to give both oral and written findings arising from his pursuit of it. General instructions are given to the student before the close of the preceding Session in order to assist a considered choice.

DEPARTMENT OF MECHANICAL ENGINEERING

302. Engineering Thermodynamics. A. B. Allan.
Course 1, II Year; 2 hrs. lectures per week, second term.
The fundamentals of engineering thermodynamics. The First and Second Laws. Properties of substances. Heat transfer. Heat exchangers. Compressors, fans, pumps, reciprocating engines and turbines. Vapour and gas power cycles. Refrigeration. Air-conditioning.
Textbook: *Basic Thermodynamics*—Brown.

303. Elementary Heat Engineering. P. B. Hughes.

Course 3, II Year; 2 hrs. lecture per week, second term.

The history and development of heat engines, the principles upon which they operate, and the characteristic features of the different kinds of engines used in practice. The First and the Second laws of thermodynamics.

Textbook: *Elements of Thermodynamics and Heat Transfer*—Obert and Young.

Reference books: *Thermodynamics of Heat Power*—Faires. *Steam, Air and Gas Power*—Severns, Degler and Miles.

306. Engineering Thermodynamics. W. J. Moroz.

Course 2, III Year; 1 hr. lecture per week, both terms.

Thermodynamics of gases and vapours as applied to engines, nozzles, turbines, compressors, heat exchangers, refrigeration plants, and air conditioning systems. Analysis of vapour and gas power cycles.

Textbook: *Thermodynamics of Heat Power*—Faires.

307. Heat Engineering Laboratory.

Course 2, III Year; 3 hrs. laboratory per week, second term.

This laboratory is complementary to subject number 306. The testing procedures and evaluation methods applicable to prime mover and compressor equipment are emphasized.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

308. Heat Engineering. F. C. Hooper, W. A. Wallace.

Course 3, III Year; 2 hrs. lecture per week, first term; 1 hr. lecture per week, second term.

A continuation of subject 303 and complementary to subject 309, this course deals with steam generators including combustion calculations, fuel and exhaust product analysis, and boiler testing and design; with internal combustion engines; with heat transmission; and with psychrometry and air conditioning.

Textbook: *Power Plant Theory and Design*—Potter.

Reference book: *A.S.H.R.A.E. Guide.*

309. Engineering Thermodynamics. F. C. Hooper.

Course 3, III Year; 2 hrs. lectures per week, both terms.

Continuation of subject 303.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer. Regeneration.

Textbook: *Elements of Thermodynamics and Heat Transfer*—Obert and Young.

310. Heat Engineering Laboratory.

Course 3, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subjects 303, 308 and 309. The experimental work, conducted on a broad range of heat and power equipment, is intended to offer experience in the design, organization and execution of experimental investigations of thermal apparatus, in the application and evaluation of the associated instrumentation, in the treatment of the data, and in the interpretation and reporting of the work.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

311. Engineering Thermodynamics. W. J. Moroz.

Course 4, III Year; 2 hrs. lectures per week, second term.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles used in practice for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer.

Textbook: *Thermodynamics of Heat Power*—Faires.

312. Heat Engineering Laboratory.

Course 4, III Year; 3 hrs. laboratory per week, second term.

This laboratory is complementary to lecture subject 311. Selected experiments are conducted in illustration of the methodology of experimental investigation of the external characteristics of thermal devices and systems, with special attention given to the peculiar interests of the engineer primarily concerned with economic considerations.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

313. Heat Engineering. C. H. Miller.

Course 5nt, III Year; 1 hr. lecture per week, both terms.

This course consists of a study of the fundamental concepts of macroscopic thermodynamics, and their applications to closed and open dynamic systems. An examination of the principal power cycles is undertaken in relation to the properties of the working media involved. Emphasis is placed on a thorough understanding of the three basic laws of thermodynamics.

Textbook: *Concepts of Thermodynamics*—Obert.

Reference books: *Engineering Thermodynamics*—Hall and Ibele.

Thermodynamics—Van Wylen.

314. Heat Engineering Laboratory.

Course 5nt, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subject 313. The course emphasizes the philosophy and techniques used in the experimental investigation of the performance of heat engineering equipment.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

315. Engineering Thermodynamics. P. B. Hughes.
Course 6, III Year; 2 hrs. lecture per week, first term.
The theory and practice of heat engines, including a study of fundamental principles involved, an appraisal of theoretical developments, and a survey of the corresponding practical applications.
Textbook: *Thermodynamics of Heat Power*—Faires.

316. Heat Engineering Laboratory.
Course 6, III Year; 3 hrs. laboratory per week, second term.
This laboratory is complementary to lecture subject 315. Experiments are conducted on heat engineering equipment presenting testing and control problems similar to those encountered in the process industries.
Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

317. Thermodynamics. A. B. Allan.
Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.
A development of the fundamental laws of thermodynamics and of their application in engineering. Internal combustion and steam power, refrigeration, heat transfer, psychrometry and air conditioning.
Textbook: *Thermodynamics of Heat Power*—Faires.

318. Heat Engineering Laboratory.
Course 7, III Year; 3 hrs. laboratory per week, first term.
This laboratory is complementary to lecture subject 317. Particular emphasis is placed on the experimental determination of the control and output characteristics of prime movers and of the energy balances in heat power plants.
Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

321. Mine Ventilation and Allied Problems. W. J. Moroz.
Course 2, IV Year; 2 hrs. lectures per week, first term.
Ventilation problems in Canadian mines, including the use of ventilation equipment, selection of fans, testing equipment, ventilation studies, the silicosis problem, fire control, etc.

322. Thermal Energy Conversion I. P. B. Hughes, D. G. Andrews.
Course 3, IV Year; 2 hrs. lectures per week, both terms.
A continuation of subjects 308 and 309, and complementary to subject 323, this course deals with the plants and processes used in major power production. The overall design and heat balance in steam power plants is considered, and their components are examined. Both conventional fossil fuel and nuclear energy

sources are considered. New developments and trends, such as magnetohydrodynamic power generation, are introduced.

Textbook: *Power Plant Theory and Design*—Potter.

323. Thermal Energy Conversion II. W. A. Wallace.

Course 3, IV Year; 2 hrs. lectures per week, second term.

A continuation of subjects 308 and 309, and complementary to subject 322, this course deals with non-central power production as for shaft power, propulsion, and similar applications. A survey of present and potential fuel resources. Operating cycles and characteristics of internal combustion engines, including reciprocating, rotary positive and gas turbine types. Rockets and ramjets. Design factors. The principles and potential of devices under current development, including fuel cells, thermoelectric converters and similar primary power producers.

Reference book: *The Internal Combustion Engine*—Taylor and Taylor.

324. Heat Engineering Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

This laboratory is complementary to lecture subjects 322 and 323. It is an extension of the third year laboratory, subject 310, with an increased demand for individual judgment and a professional outlook.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

325. Refrigeration and Air Conditioning. F. C. Hooper.

Course 5t, IV Year; 2 hrs. lecture per week, first term.

The thermodynamic cycles and processes of special interest in refrigeration are outlined and the properties of ideal and actual refrigerants examined. Basic psychrometric processes are reviewed and related to air conditioning system performance.

Textbook: *Theory of Mechanical Refrigeration*—Sparks and Di Ilio.

Reference book: *A.S.H.R.A.E. Guide.*

326. Heat Power Engineering. C. H. Miller.

Course 5t, IV Year; 1 hr. lecture per week, both terms.

Application of thermodynamics to the design of power plant equipment of all types including gas turbines, subcritical and supercritical vapour cycles, and combinations thereof. New developments and trends are emphasized by consideration of the problems associated with nuclear reactor energy sources, magnetoplasmadynamics power generation, fuel cells and extra-terrestrial environmental conditions. Departures of real cycles from idealized analytical models are considered in some detail.

References: *Cycles and Performance Estimation*—Hodge. *Analytical Thermodynamics*—Soo. *Power Plant Theory and Design*—Potter. Selected Papers from Current Literature.

327. Internal Combustion. A. B. Allan.

Course 5t, IV Year; 1 hr. lecture per week, both terms.

Analysis of the processes and fundamental problems of internal combustion machines. Consideration of the deviations from ideal behaviour. Fuels, combustion, ignition, detonation and other combustion problems. Experimental techniques in the study of internal combustion machines. A consideration of engine design.

Textbook: *Internal Combustion Engines*—Obert.

Reference book: *Internal Combustion Engines*—Lichty.

328. Heat Transfer. F. C. Hooper.

Courses 5t and 5n, IV Year; 2 hrs. lecture per week, second term.

Steady state and transient conduction, surface and gas radiation, convection, boiling, condensation and combined mechanisms are considered. Special attention is given to analogue and computational procedures and to consideration of the manner in which novel or complex problems may be approached.

Textbook: *Heat Transmission*—McAdams.

329. Heat Engineering Laboratory.

Course 5t, IV Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subjects 325, 326, 327 and 328, and an extension of laboratory subject 314. The laboratory offers an opportunity for specialized individual undertakings.

330. Heat Transfer. C. H. Miller.

Course 8, IV Year; 2 hrs. lectures per week, first term.

Basic principles, definitions, units and dimensional analysis. Conduction in the steady and the unsteady states. The heat source within a conducting body. Free and forced convection. Condensing and boiling. Radiation. Combined effects of conduction, convection and radiation. Instrumentation and experimental methods.

Textbook: *Heat Transfer*—Chapman.

331. Thermal Energy Conversion. F. C. Hooper, C. H. Miller, A. B. Allan.

Course 5nt, IV Year; 3 hrs. lectures per week, both terms. (Commencing in the Session 1966–67.)

The thermodynamics and gas dynamics of thermal energy conversion. Steam power cycles, nuclear reactor and fossil fuel energy sources, magnetohydrodynamic power generation, fuel cells, combustion, refrigeration, new trends and research developments.

332. Heat Engineering Laboratory.

Course 5nt, IV Year; 3 hrs. laboratory per week, both terms. (Commencing in the Session 1966–67.)

This laboratory is complementary to lecture course 331, and an

extension of course 314. The techniques of testing, the design of experiments, the application of instrumentation, and the organization and reporting of performance tests are emphasized.

333. Fluid Mechanics. G. R. Lord, W. D. Baines.

Courses 1 and 3, III Year; 2 hrs. lectures per week, both terms.

Attention is given to the development and discussion of the fundamental principles of fluid flow. These principles are illustrated by suitable practical problems connected with fluid measurements, flow of fluids in pipes and open channels, with a brief discussion of the resistance of submerged bodies, dimensional analysis and similarity studies.

334. Fluid Mechanics Laboratory.

Courses 1 and 3, III year; one 3 hr. laboratory period per week, second term.

This laboratory course is planned to illustrate the principles considered in the lecture courses in fluid mechanics. Experimental work in the laboratory utilizes a wide variety of apparatus and equipment concerned with fluid flow, while problems undertaken in the study room provide a link with general engineering practice.

335. Fluid Flow and Pumping Systems. E. Brundrett.

Course 2, III Year; 3 hrs. lectures per week, first term.

A discussion of the fundamental principles of fluid flow, with special attention to problems encountered in mining.

336. Fluid Flow and Pumping Systems Laboratory.

Course 2, III Year; 3 hrs. laboratory per week, first term.

A course of laboratory experiments and design problems to permit correlation of flow fundamentals with mining applications.

337. Fluid Mechanics. E. Brundrett, J. F. Keffer.

Courses 4 and 6, III Year; 2 hrs. lectures per week, first term.

The fundamentals of fluid flow as generally encountered in industry. Fluid properties, fluid statics, energy relations, dimensional analysis and dynamic similarity, flow in pipes and channels, resistance of submerged bodies, effects of viscosity and compressibility, lubrication, pumps and other hydraulic machines.

338. Fluid Mechanics Laboratory.

Courses 4 and 6, III Year; 3 hrs. laboratory per week, first term.

A course of laboratory experiments and design problems to permit of correlating flow fundamentals with industrial applications.

339. Fluid Mechanics. W. D. Baines.

Courses 5c and 5nt, III Year; 2 hrs. lectures per week, both terms.

Introductory concepts; vector analysis; inviscid flow, incompressible and compressible; similitude and models; conduit systems; gravity effects; fluid machinery.

340. Fluid Mechanics Laboratory.

Courses 5c and 5nt, III Year; 3 hrs. laboratory per week, both terms.

Problems and experiments related to subject 339.

341. Hydraulic Engineering. H. L. Leutheusser.

Course 1, IV Year, Option C; 2 hrs. lectures per week, both terms.

Applications of fluid mechanics to civil engineering problems, particularly discussion of flow in pipes and open channels, surge tanks, water hammer, pumps and turbines. Theory and applications of hydrology including precipitation, run-off, snowmelt, ground water, evaporation and hydrograph analysis.

342. Hydraulic Engineering Laboratory.

Course 1, IV Year, Option C; one 1½-hr. laboratory period per week, first term; one 3-hr. laboratory period per week, second term.

Experimental studies of hydraulic models, turbines and pumps are carried out. Problems assigned in the study rooms deal with channel flow and other hydraulic features connected with water power installations, flood control, water supply and drainage systems.

343. Hydraulic Engineering. E. Brundrett.

Course 1, IV Year, Options A, B, D; 2 hrs. lectures and 3 hrs. laboratory per week, second term.

The general field of hydraulic engineering is studied under the topics: hydrology; ground and surface water; drainage, flood control, power and navigation systems; municipal and industrial applications; model studies; principles of design, operation, and field investigation.

344. Hydraulics. G. R. Lord.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

The general field of applied hydraulics and fluid mechanics is studied under the topics: hydrology; hydro-electric power plants and auxiliaries; conservation and flood control; canals, pipelines, etc., under both steady and unsteady conditions; hydraulic machinery, fans, compressors, turbines, pumps, etc., design, selection and operation; power and control circuits; flow of compressible fluids; similarity and model investigations; industrial applications.

345. Hydraulic Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

Experimental work is carried out in the laboratory on various types of pumps, turbines, fans, centrifugal compressors and on hydraulic models. In addition computation problems involving open channel flow, water power studies, pumps and turbine studies, water hammer phenomena, fans and ductwork and other advanced flow problems are considered. General problems involving compressibility of gases are considered.

346. Fluid Mechanics. J. F. Keffer.

Course 7, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Physical characteristics of fluids; fundamental concepts of fluid mechanics; experimental techniques and principles of systematic analysis; boundary layers, wakes and turbulence; pipe and channel systems; dynamics of compressibility; oscillations and waves; forces and moments on immersed bodies; fluid machinery; introduction to systems encountered in engineering practice.

347. Fluid Mechanics Laboratory.

Course 7, IV Year; 3 hrs. laboratory per week, second term.

Laboratory experiments and design problems to illustrate subject 346.

348. Fluid Mechanics. H. J. Leutheusser.

Course 8, IV Year; 2 hrs. lectures and 1½ hrs. laboratory per week, second term.

The fundamentals of fluid flow as generally encountered in industry. Fluid properties, fluid statics, kinematics, dynamics, dimensional analysis and dynamic similarity, flow in pipes and channels, flow about submerged objects, flow machines.

350. Dynamics. G. E. Godfrey.

Courses 1 and 4, II Year; 2 hrs. lectures per week, second term.

Motion of a point is reviewed and extended to include Coriolis' acceleration, with applications. Equations for motion of mass in translation, rotation, and plane motion are developed, including centre of percussion. Moment of inertia of mass is studied by double integration and by the lamina method. The derivation and application of gyroscopic action is thoroughly discussed, and an introduction to static and dynamic balancing is given. Elementary vibration theory and problems in vibration isolation are discussed.

Textbook: *Engineering Dynamics*—Hooper and Smith.

Reference book: *Mechanics*—Part II—Meriam.

351. Dynamics. F. P. J. Rimrott.

Course 5, II Year (elective); 2 hrs. lectures per week, first term.

Simple particle motion. Work and energy. Impulse and momentum. Kinematics of plane motion and Coriolis' acceleration. Kinetics of translation and rotation. General kinetics of plane motion.

Gyroscopic action. Simple vibrations. Gibbs' Vector Notation.

Textbook: *Mechanics*, Part II—Meriam.

Reference book: *Engineering Dynamics*—Hooper and Smith.

352. Dynamics. F. P. J. Rimrott.

Course 7, II Year; 2 hrs. lectures per week first term; 1 hr. lecture per week, second term.

Motion of a point, including Coriolis' acceleration; motion of mass; gyroscopic action; vibration and balancing; electro-mechanical analogies; Gibb's vector notation.

Textbook: *Engineering Dynamics*—Hooper and Smith.

Reference book: Mechanics, Part II—Meriam.

353. Dynamics Laboratory. F. P. J. Rimrott.

Course 7, II Year; 1½ hrs. problems per week, both terms.

Problems in kinematics and kinetics to support subject 352.

355. Mechanical Engineering. B. M. M. Carpendale.

Course 3, II Year; 1 hr. lecture per week, first term.

Prior to registering in Second Year, the student is required to study the prescribed text, covering the topics of design materials and manufacturing methods and processes. The lecture work will involve discussion of the text matter, as well as new materials and processes. The final examination (in January) will cover both the prescribed study and the lecture work.

Textbook: *Manufacturing Processes and Materials for Engineers*—Doyle, Morris, Leach and Schrader.

356. Machine Design. I. W. Smith, R. T. Waines.

Course 3, II Year; 2 hrs. lectures per week, second term.

Design of machine elements—shafts, bearings, belts, couplings, clutches.

Textbook: *Design of Machine Elements*—Spotts.

357. Dynamics of Machines. D. L. Allen.

Course 3, II Year; 3 hrs. lectures per week, both terms.

Basic equations for accelerated motion of mass are developed and applied to the analysis of machine elements. Velocity, acceleration, force distribution, speed fluctuation and balancing of machines are considered. Standard linkages, cams, gears, flywheels, governors and gyroscopes are given specific attention.

Textbooks: *Engineering Dynamics*—Hooper and Smith. *Kinematics and Dynamics of Machinery*—Maxwell.

358. Machine Design Laboratory. R. T. Waines, D. L. Allen, B. M. M. Carpendale.

Course 3, II Year; 6 hours per week, both terms.

Problems in mechanical drawing, descriptive geometry, fits and tolerances, machine tool operations, dynamics of machines, metrology, and design of machine elements.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

359. Mechanical Design. R. T. Waines.

Course 4, II Year; 1 hr. lecture per week, both terms.

Machines and Processes. In addition, standards, allowances and fits, metrology and machine tool operations.

Textbook: *Manufacturing Processes and Materials for Engineers*—Doyle, Morris, Leach and Schrader.

360. Mechanical Design Laboratory. R. T. Waines, B. M. M. Carpendale.

Course 4, II Year; 6 hrs. per week, both terms.

Problems in mechanical drawing, descriptive geometry, fits and tolerances, machine tool operations, machine force analysis, and metrology, the latter being given in the Fine Measurement Laboratory.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

363. Machine Design. I. W. Smith, R. T. Hartlen.

Course 3, III Year; 2 hrs. lectures per week, first term.

Stress analysis, deflections, failure theory, fluctuating stress, and the design of various machine elements, including screw threads for fastening, shafting, bearings, belts, pulleys, spur gears, flywheels, keys, clutches, etc.

Textbook: *Design of Machine Elements*—Spotts.

364. Machine Design Laboratory. R. T. Waines, I. W. Smith, R. T. Hartlen.

Course 3, III Year; 6 hrs. per week first term; 3 hrs. per week second term.

Design and stress analysis of machine elements; vibration problems and experiments in one and two mass systems.

365. Applied Elasticity. J. VandeVegte.

Courses 5n, 5p, 5t, III Year; 1 hr. lecture per week, both terms.

Introduction (simple equations for normal and shear stresses; stress concentrations; fluctuating stresses and fatigue). Analysis of stress and strain in three dimensions, including use of primary and auxiliary Mohr's circles, and application to bending and torsion problems. Deflection analysis of statically determinate and indeterminate structures. Additional topics and applications include: Analysis of plates and shells, torsion of thin-walled tubes, stability of columns, thermal stresses.

366. Applied Elasticity Laboratory. I. W. Smith, R. T. Waines, J. VandeVegte.

Courses 5n, 5p, 5t, III Year; 3 hrs. laboratory per week, both terms.

Problems to support subject 365.

367. Machine Design. G. E. Godfrey.

Course 7, III Year; 2 hrs. per week, first term.

Force analysis; mechanics; velocities, accelerations and inertia

forces in machines; principles of stress analysis and the design of various machine elements, including shafting, bearings, belts, gears, etc.; also an introduction to work on speed fluctuation, vibrations and balancing.

Textbook: *Design of Machine Elements*—Spotts.

368. Machine Design Laboratory. R. T. Waines, G. E. Godfrey.

Course 7, III Year; 3 hrs. per week, first term.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

371. Machine Design. R. L. Sakaguchi.

Courses 2, IV Year; 1 hr. lecture per week, both terms.

The design and selection of machinery and equipment met with in metallurgical plants, and in mining work.

Textbook: *Design of Machine Elements*—Spotts.

372. Machine Design Laboratory. I. W. Smith, R. T. Waines, R. L. Sakaguchi.

Course 2, IV Year; 3 hrs. laboratory per week, second term.

Problems worked out in the laboratory, designed to give the student training in the general lay-out of shafting and plant machinery, as well as in the design of simple parts for metallurgical apparatus, and mine machinery.

373. Machine Design. I. W. Smith, R. T. Waines, G. E. Godfrey, D. L. Allen, G. W. J. Pottow.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

This is a continuation of subjects 363 and 357. It will involve the design of various machine elements and equipment including machine frames, hooks, hoisting equipment, crankshafts, gears (helical, herringbone, bevel, screw, and worm), springs, clutches, brakes, thin and thick wall vessels.

An introduction will be given to the study of vibration problems encountered in high speed engines and machines.

Textbooks: *Design of Machine Elements*—Spotts. *Mechanical Vibrations*—Thomson.

374. Machine Design Laboratories. I. W. Smith, R. T. Waines, G. E. Godfrey.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

Advanced laboratory work involves both analysis and design of machine elements, machine units, and complete machines. The selection of problems is made with a view to giving the student as broad a coverage as possible and providing experience in combining of elements to form a machine of smooth and harmonious design. Some of this work will involve special shafting problems including graphical solutions, critical speeds, and multiple supports.

Work will be given in the Mechanical Laboratory on gauging and fine measurements, experimental stress analysis, vibration, and bearing testing.

375. Machine Design. G. E. Godfrey.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Force analysis; mechanics, velocities, accelerations and inertia forces in machine; stress analysis; deflections; failure theory; fluctuating stress, and design of various machine elements including shafts, bearings, belts, gears, riveted and welded parts, etc.; also an introduction to speed fluctuation and vibrations.

Textbook: *Design of Machine Elements* (third edition)—M. F. Spotts.

376. Machine Design Laboratory. R. T. Waines, G. E. Godfrey.

Course 4, IV Year; 3 hrs. per week, both terms.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

377. Machine Design. J. VandeVegte.

Course 5t, IV Year; 2 hrs. lectures per week, second term.

A series of lectures on design methods related to heat engines, including force analysis, speed fluctuation, flywheel design, governors, vibrations, high speed bearings, and thermal stress.

Reference books: *Mechanism and Dynamics of Machinery*—Mabie and Ocvirk. *Analysis and Lubrication of Bearings*—Shaw and Macks. *Design of Machine Elements*—Spotts.

378. Machine Design. R. T. Waines.

Course 6, IV Year; 2 hrs. lectures per week, first term.

The design of various machine elements, particularly those likely to be met with in chemical plants, and an outline of the properties, production methods, and selection of materials used in machine equipment.

Textbook: *Design of Machine Elements* (3rd Ed.)—M. F. Spotts.

Reference book: *Design of Machine Elements*—Faires.

383. Mathematical Analysis. Staff in Mechanical Engineering.

Courses 3, 4 and 8, II Year; 1½ hrs. problems per week, both terms.

Solution of engineering problems by mathematical analysis, with particular reference to the work of subject 2420.

386. Engineering Analysis. Staff in Mechanical Engineering.

Course 3, III Year; 1½ hrs. problems per week, first term; 3 hrs. problems per week, second term.

Exercises in reducing physical problems to analytical statements, with emphasis on the formulation of differential equations, the solutions of the mathematical problems involved, and the physical

interpretation of these solutions; assessment of the validity of mathematical models.

Reference books: *Engineering Analysis*—verPlanck and Teare; *Creative Engineering Analysis*—Ryder.

387. Treatment of Technical Data. L. E. Jones.

Course 3, III Year; 2 hrs. lectures per week, and 3 hrs. problems per week, second term.

Presentation of data; approximate nature of technical data; role played by mathematics; general numerical methods including FORTRAN computer language; methods of organizing data for computation; methods of analyzing technical data; elements of curve-fitting and statistical treatment.

390. Applied Mathematics in Engineering. L. E. Jones.

Course 3, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term; 3 hrs. problems per week, both terms.

Dimensional analysis and similarity, numerical methods, relaxation techniques, approximate solutions, digital and analogue computation, including FORTRAN computer programming, introduction to statistics and operations research.

391. Elementary Control Theory. J. VandeVegte.

Course 3, IV Year; 1 hr. lecture per week, both terms.

An introduction to the principles utilized in the analysis of linear control systems. Emphasis is also placed on the synthesis of mathematical models of simple systems, and the limitations inherently involved. Topics include stability criteria, characteristics of electrical, pneumatic and hydraulic control elements, and capabilities of feedback systems. A brief introduction to the problems arising from non-linear prototypes is included.

Recommended text: *Automatic Control Engineering*—Raven.

392. Elementary Control Theory Laboratory. J. VandeVegte.

Course 3, IV Year; 3 hrs. laboratory per week, second term.

Problems and experiments related to subject 391 are dealt with.

393. Computational Methods. L. E. Jones.

Course 5t, IV Year; 1 hr. lecture per week, 3 hrs. problems per week, first term.

Practical extension of Subjects 2427 and 2428 to provide advanced computing experience with desk calculators and with analogue and digital computers. FORTRAN computer language will be studied in detail. Emphasis is placed on the economic use of available numerical procedures in the solution of engineering problems.

396. Industrial Management. B. M. M. Carpendale, P. B. Hughes.

Courses 3, 6, 7, IV Year; 1 hr. lecture per week, first term.

Introduction to principles of management and organization. Subjects 3440 and 396 are combined in one examination.

398. Control Systems.

Course 5nt, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term. (Commencing in the Session 1966–67.)

A course in linear and non-linear control systems.

399. Control Systems Laboratory.

Course 5nt, IV Year; 3 hrs. laboratory per week, second term. (Commencing in the Session 1966–67.)

A laboratory course accompanying course 398.

DEPARTMENT OF INDUSTRIAL ENGINEERING

401. Operations Research I. D. J. Clough.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Methods of determining economic optima in industrial operations. Applications of mathematical techniques such as Lagrange multipliers, linear programming, non-linear programming, dynamic programming, to problems in production scheduling and sequencing, inventory control, transportation, equipment investment, utilization of scarce resources, and so on.

Recommended text: *Concepts in Management Science*—Donald J. Clough, Prentice-Hall Inc.

402. Operations Research I Laboratory. D. J. Clough.

Course 4, IV Year; 3 hrs. laboratory per week, both terms.

Practical work to accompany subject 401. Case studies and problem assignments.

403. Operations Research II. D. J. Clough.

Course 4, IV Year; 2 hrs. lectures per week, second term.

Applications of probability theory and statistical analysis to problems in industrial operations. Markov theory applied to queuing, inventory, maintenance, and machine replacement problems. Statistical methods of estimation applied to the same problem areas.

Recommended text: *Concepts in Management Science*—Donald J. Clough, Prentice-Hall Inc.

404. Operations Research II Laboratory. D. J. Clough.

Course 4, IV Year; 3 hrs. laboratory per week, second term.

Practical work to accompany subject 403. Case studies and problem assignments.

405. Dynamics of Industrial Systems. R. W. P. Anderson.

Course 4, IV Year; 2 hrs. lectures per week, first term.

The design and analysis of industrial systems, with particular emphasis on dynamic feedback models to simulate system behaviour. (Also see subject 406.)

406. Dynamics of Industrial Systems Laboratory. R. W. P. Anderson.

Course 4, IV Year; 3 hrs. laboratory per week, first term.

The M.I.T. Dynamo compiler is used in conjunction with the I.B.M. 7094 computer to simulate the dynamic behaviour of the systems dealt with in subject 405.

407. Elementary Control Theory. A. Porter.
Course 4, IV Year; 2 hrs. lecture per week, both terms.
The dynamic behaviour of simple linear mechanical and electrical networks; weighting functions and transfer functions of linear elements; the principles of analogue and digital computers; introduction to Boolean Algebra and its applications; elements of information theory and its control implications; introduction to linear servomechanisms and manually operated control systems.

408. Elementary Control Theory Laboratory. A. Porter, L. Magagna.
Course 4, IV Year; 3 hrs. laboratory per week, both terms.
Problems and laboratory experiments related to subject 407.

409. Current Developments in Industrial Engineering. The Staff in Industrial Engineering.
Course 4, IV Year; 2 hrs. lectures per week, second term.
A selection of topics emphasizing subjects of current technical interest in the field of Industrial Engineering. The interdisciplinary character of Industrial Engineering will guide the choice of specific treatment, perhaps from the fields of control theory, information theory, computer developments, management systems, biomedical problems, etc.

410. Current Developments Laboratory. The Staff in Industrial Engineering.
Course 4, IV Year; 2 hrs. laboratory per week, second term.
Readings in the topics of course 409 from the current technical literature will be assigned and two short essays will be required of each student.

411. Industrial Engineering Seminar.
Course 4, IV Year; 2 hrs. laboratory per week, second term.
Invited speakers, prominent in the Academic, Governmental, and Business communities, will conduct a series of talks followed by general discussion. An essay based on one of these sessions will be required.

412. Operations Research. A. Porter, J. W. Abrams.
Course 2, III Year; 2 lectures per week, first term.
The history of operations research; introduction to statistical mathematics; selected topics in O.R. methodology, e.g., replacement theory, inventory theory, transportation theory, queuing theory; introduction to electronic data processing.

413. Operations Research Laboratory. A. Porter, J. W. Abrams.
Course 2, III Year; 1½ hrs. per week, first term.
Problems and case histories associated with subject 412.

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

600. Chemistry. The Staff in Chemical Engineering.
Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.
Chemical theory, with industrial and engineering applications.

601. Chemical Laboratory. W. F. Graydon, A. M. Rozeiu.
Courses 1, 3, 4, 5, 6, 7, 8 and 9, I Year; 3 hrs. laboratory per week, both terms.
A laboratory course illustrating the fundamental laws of chemistry as dealt with in the lecture course, and providing an introduction to chemical analytical methods.

602. Chemistry. W. H. Burgess.
Course 5, I Year; 2 hrs. lectures per week, both terms.
Introductory physical chemistry: the gas laws, chemical equilibria, elementary solution chemistry, thermochemistry. Problems dealing with industrial and engineering applications.

605. Chemistry. W. F. Graydon, M. J. Phillips.
Course 2, II Year; 2 hrs. lectures per week, first term.
Calculations based on systems in equilibrium; examples from pH, solubility, complex formation and phase equilibrium.

606. Analytical Chemistry Laboratory. W. F. Graydon, M. J. Phillips.
Courses 2 and 9, II Year; 6 hrs. laboratory per week, first term.
Volumetric and gravimetric analysis.

607. Engineering Chemistry. W. H. Rapson, S. Sandler.
Courses 1, 3, and 4, II Year; 2 hrs. lectures per week, first term.
Corrosion and water-treatment; introduction to organic chemistry.

608. Physical Chemistry. R. W. Missen.
Course 5, II Year; 2 hrs. lectures per week, both terms.
A continuation of subject 602. Topics discussed include phase and reaction equilibrium, the latter following an introduction to chemical thermodynamics, reaction kinetics and electrochemistry.
Textbook: *Physical Chemistry*—Daniels and Alberty—2nd edition.

609. Chemistry Laboratory. Staff in Chemical Engineering.
Course 5, II Year; 3 hrs. laboratory, alternate weeks, both terms.
Laboratory exercises to accompany subject 608.
Ten laboratory reports.

610. Chemical Engineering Science Laboratory. Staff in Chemical Engineering.
Course 5, II Year (elective); 3 hrs. laboratory per week, second term.

An experimental introduction to physical rate processes. Electrical, fluid flow, heat transfer, and mass transfer systems with varied capacities are used to illustrate the dependence of the rate of transfer on driving force, resistance, etc.

Three laboratory reports.

613. Analytical Chemistry Laboratory. I. H. Spinner, M. E. Charles, J. Binkiewicz.

Course 6, II Year.

This course commences on the Wednesday following the first Monday in September, and continues until the opening of the Fall Term. All the working time will be spent on systematic quantitative inorganic analysis and machine computation of complex equilibria.

Textbook: *Textbook of Inorganic Analysis*—Kolthoff and Sandell.

614. Analytical Chemistry Laboratory. I. H. Spinner, J. Binkiewicz, C. P. Brockett.

Course 6, II Year; 9 hrs. laboratory per week, first term.

A continuation of Subject 613.

615. Analytical Chemistry. I. H. Spinner.

Course 6, II Year; 2 hrs. lectures per week, first term.

Equilibrium considerations in quantitative analysis.

616. Industrial Chemistry. W. G. MacElhinney.

Course 6, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Manufacture of acids, alkalis, and inorganic chemicals, water-treatment, corrosion, explosives.

617. Inorganic Chemistry. R. E. Jervis, H. D. Sharma.

Courses 6, 8 and 9, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

The constitution of matter and classification of the elements: systematic inorganic chemistry.

618. Organic Chemistry. J. G. Breckenridge.

Course 6, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

An introductory course in organic chemistry, with emphasis on reaction conditions and yields, and the industrial significance of certain compounds and reactions.

Textbook: *Systematic Organic Chemistry*—Muldoon and Blake.

619. Chemical Engineering Science Laboratory. I. H. Spinner, C. P. Brockett, R. L. Hummel, J. W. Smith.

Course 6, II Year; 7 hrs. laboratory per week, second term.

Experiments illustrating the kinetic and equilibrium principles of chemical engineering. Mass and heat balance calculations.

One laboratory report per week.

620. Process Calculations. J. W. Smith, I. H. Spinner.
Course 6, II Year; 3½ hrs. laboratory per week, second term.
Process calculations in chemical engineering.
Textbook: *Basic Principles and Calculations in Chemical Engineering*—Himmelblau.

625. Chemical Theory A. W. H. Burgess, W. F. Graydon.
Course 6, III Year; 1 hr. lecture per week, both terms.
Chemical kinetics; principles of adsorption and colloid chemistry.

627. Chemical Laboratory. W. F. Graydon, Z. May.
Course 6, III Year; 6 hrs. laboratory per week, both terms.
A laboratory course to accompany subject 626.
One laboratory report.

628. Organic Chemistry. J. G. Breckenridge.
Course 6, III Year; 2 hrs. lectures per week, both terms.
A continuation of subject 618, dealing mainly with aromatic compounds.

629. Organic Chemistry Laboratory. W. H. Rapson, Z. May.
Course 6, III Year; 9 hrs. laboratory per week, first term; 6 hrs. laboratory per week, second term.
A laboratory course accompanying subject 628.

630. Industrial Chemistry. W. G. MacElhinney, W. H. Rapson.
Course 6, III Year; 3 hrs. lectures per week, second term.
Chemical process industries, including petroleum, soap, sugar, pulp and paper, and fermentation industries. In preparation for this course, students will be expected to have read and to be thoroughly familiar with the following: Chemical Process Industries—Shreve: Chapters 29, 30, 31, 33, 34, 37.

631. Introduction to Mass and Heat Transfer. W. G. MacElhinney.
Course 6, III Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.
The fundamental theory and practice used in transfer operations in chemical engineering. Energy and mass transfer are considered in the study of the flow of fluids, fluidization of solids, heat transfer, and evaporation of solutions.
Textbook: *Principles of Unit Operation*—Foust, Wenzel, Clump, Maus, and Andersen.

632. Public Speaking. W. H. Rapson, S. Sandler, M. Wayman.
Course 6, III Year; 1 hr. per week, both terms.

633. Applied Mathematics in Chemical Engineering. R. L. Hummel, R. W. Missen, I. H. Spinner.
Course 6, III year; 1 hr. lecture and 1 hr. problem period per week, both terms.
A course in the formulation of differential equations describing

typical chemical engineering situations. The solution of these equations will be obtained primarily by analogue and numerical methods. The second part is a course in the attack and solution of problems in applied chemistry and chemical engineering requiring a knowledge of the rational design of experiments and the treatment of experimental data.

640. Chemical Engineering Thermodynamics. W. F. Graydon.
Courses 5c and 6, III Year; 2 hrs. lectures per week, both terms.
A course in classical thermodynamics with problems in the field of applied chemistry and chemical engineering. Special emphasis is placed on chemical processes and compositional changes.

641. Chemical Engineering Rate Processes. O. Trass.
Course 5c, III Year; 2 hrs. lectures per week, both terms.
The kinetic theory of gases. Mechanisms and rates of homogeneous chemical reactions. Physical transport mechanisms and estimation of transport properties. Application to reaction kinetics and momentum, heat, and mass transfer.

642. Chemical Engineering Problems and Laboratory. Staff in Chemical Engineering.
Course 5c, III Year; 9 hrs. per week, first term; 7½ hrs. per week, second term. Problems and laboratory experiments illustrating topics discussed in Subjects 640 and 641.

650. Mass Transfer Operations. O. Trass.
Courses 5c and 6, IV Year; 2 hrs. lectures per week, both terms.
The theory and practice of mass transfer operations in chemical engineering are discussed. Many problems in distillation, extraction, absorption, and other operations illustrate the course.
Textbook: *Mass Transfer Operations*—R. E. Treybal.

651. Chemical Plant Design. R. W. Missen, J. W. Smith, M. Wayman.
Course 6, IV Year; 1 hr. lecture and 3 hrs. laboratory per week, both terms.
The lectures deal with selected topics in plant design: process design, plant location, economics. In the second term, process design calculations are done for a particular plant, ending with an economic evaluation of the process. If possible, a visit is made to a nearby operating plant to illustrate the work done in the laboratory.
Textbook: *Chemical Engineering Plant Design*—Vilbrandt and Dryden.
Reference book: *Chemical Engineering Cost Estimation*—Aries and Newton.

652. Chemical Engineering Laboratory. R. L. Hummel, W. G. MacElhinney, J. W. Smith, O. Trass.
Courses 5c and 6, IV Year; 9 hrs. laboratory per week, first term.

A laboratory course to accompany subjects 631, 650, and 651. Bench and pilot plant experiments are carried out to study a variety of unit operations such as fluidization, heat transfer, evaporation, filtration, distillation, extraction, and absorption. Modern control instruments are discussed and operated.

One laboratory report per week.

653. Applied Mathematics in Chemical Engineering. R. W. Missen.

Course 6, IV Year; 3 hrs. laboratory per week, first term.

A problems course dealing with selected topics in dimensional, graphical and numerical methods, statistics and differential equations.

Reference books: *Applied Statistics for Engineers*—Volk; *Applied Mathematics in Chemical Engineering*—Mickley, Sherwood and Reed; *Nomography and Empirical Equations*—Davis.

654. Organic Chemistry. W. H. Rapson.

Course 6, IV Year; 1 hr. lecture per week, both terms.

The chemistry of natural and synthetic high-molecular-weight materials.

655. Chemical Engineering Thermodynamics and Kinetics. W. H. Burgess, W. F. Graydon.

Course 6, IV Year; 2 hrs. lectures per week, both terms.

The application of thermodynamics and kinetics to problems in the field of chemical engineering.

660. Organic Chemistry. J. G. Breckenridge, I. H. Spinner.

Course 5c, IV Year; 2 hrs. lectures per week, first term, 1 hr. lecture per week, second term.

A lecture course in organic chemistry, concluding with a section on the chemistry of high polymers.

661. Organic Chemistry Laboratory. J. G. Breckenridge, Z. May.

Course 5c, IV Year; 6 hrs. laboratory per week, second term.

A laboratory course to accompany subject 660.

663. Instrumental Methods. S. Sandler.

Course 5c, IV Year; 2 hrs. lectures per week, second term.

The subject is designed to emphasize the science of chemical instrumentation. The principles, technique, and applications of gas-chromatographic, opticometric, electrometric, and mass-spectrometric methods of analysis are studied.

664. Process Dynamics.

Course 5c, IV Year; 2 hrs. lectures per week, both terms, 3 hrs. laboratory per week, second term.

Measurement and control of process variables; mathematical principles, instrumentation, and control systems.

Application of analogue and digital computers to chemical process simulation and optimization.

665. Chemical Engineering Thermodynamics and Kinetics. W. H. Burgess, W. F. Graydon.

Course 5c, IV Year; 3 hrs. lectures per week, both terms.

The application of the principles of chemical thermodynamics and reaction kinetics to chemical processes. Special emphasis is placed on the sizing and design of chemical reactors and the thermodynamic properties of non-ideal systems.

666. Chemical Engineering Design. J. W. Smith and Staff in Chemical Engineering.

Course 5c, IV Year; 2 hrs. lectures and 6 hrs. laboratory per week, both terms.

Applications of heat transfer and fluid flow, process economics, optimal design, and applied mathematics in chemicals engineering, chemical plant design. In the first term the laboratory is devoted to problems in these topics and in those of Subject 665; in the second term process design calculations and an economic evaluation are done for a particular chemical plant.

Reference books: *Plant Design and Economics for Chemical Engineers*—Peters. *Applied Mathematics in Chemical Engineering* —Mickley, Sherwood, and Reed. *Chemical Engineer's Handbook* —Perry.

670. Nuclear Engineering. D. G. Andrews, R. E. Jervis.

Course 5n, IV Year; 2 hrs. lectures per week, both terms.

Nuclear engineering aspects of: nuclear constitution and properties including cross-section, energetics, radioactivity, production and use of radio-isotopes, neutrons, slowing down, "age" theory, diffusion of thermal neutrons, fission.

The age and two-group theories of the reactor core. Reflected reactors (elementary treatment). Reactor kinetics, control and instrumentation.

Applications of heat transfer, fluid flow and stress analysis to the reactor core.

The measurement and control of radiation. Exposure of humans to radiation. Shielding techniques.

Nuclear engineering applications of nuclear and radio-chemistry.

671. Nuclear Engineering Laboratory. D. G. Andrews, R. E. Jervis.

Course 5n, VI Year; 3 hrs. laboratory per week, both terms.

A laboratory course to accompany subject 670.

Experiments are carried out with radiation sources and instruments, a sub-critical reactor, a reactor simulator, pulse height analyzers, fast neutrons generators and radioactive tracers.

DEPARTMENT OF ELECTRICAL ENGINEERING

700. Electricity. Staff in Electrical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

A basic course in electricity and magnetism, including Kirchhoff's Laws and network theorems as applied to direct-current circuits, induced voltages, self and mutual inductance and an introduction to electric field concepts. The MKS system of units is used.

701. Electricity. Staff in Electrical Engineering.

Course 5, I Year; 2 hrs. lectures per week, both terms.

A basic course in electricity and magnetism that is similar to subject 700 but adapted to the needs of Course 5.

710. Electric Circuits I. A. J. Kravetz.

Course 7, II Year; 3 hrs. lectures per week both terms; 2 hrs. computation, alterate weeks, both terms.

The relation of lumped parameters to field concepts, their physical realization and their variation with frequency. The representation of simple systems by lumped parameter circuits.

The analysis of linear circuits in the steady state with either direct or alternating sources. Loop and nodal methods. The elements of the topography of circuits. Coupled circuits. Response of circuits to variable frequency.

The transient response of simple linear circuits to suddenly applied sources and its relation to the steady state.

Three-phase circuits, balanced and unbalanced. Other polyphase circuits.

General network theorems, rigorously derived, including the transformation theorems.

711. Electric and Magnetic Fields. G. R. Slemon.

Course 7, II Year; 2 hrs. lectures per week, both terms; 2 hrs. computation, alternate weeks, both terms.

Electric and magnetic fields, forces and energies associated with charged and current-carrying conductors embedded in dielectric and magnetic media. Particle dynamics in electric and magnetic fields. Time-varying fields in conductors and insulators. Development of Maxwell's equations and interpretation in static and dynamic situations.

Textbook: *Scientific Basis of Electrical Engineering*—Ham and Slemon.

712. Electrical Measurements. H. A. Courtice.

Course 7, II Year; 2 hrs. lectures per week, second term.

Measurement of electrical quantities such as charge, potential difference, current, magnetic flux, energy and power. Measurement of electrical properties such as dielectric constant, permeability and conductivity. Measurement of resistance inductance and capacitance. Transducers for electrical measurement of mechanical, thermal and other physical quantities. Measurement of alternating-current quantities in single phase and polyphase systems. Accuracy of measurement, curve fitting and treatment of measured data.

713. Electrical Laboratory.

Courses 3 and 4, II Year; 3 hrs. laboratory per week, first term.

Course 7, II Year; 3 hrs. laboratory per week, both terms.

Appropriate laboratory experiments to accompany subjects 710, 712, and 714.

Courses 3 and 4. Six laboratory reports.

Course 7. Ten laboratory reports.

714. Electricity. H. A. Courtice.

Courses 3 and 4, II Year; 2 hrs. lectures per week, first term.

General principles and calculations of electrical circuits, particularly as applied to the measurement of resistance, current, potential difference, inductance, capacity, power, and energy. The principles underlying commercial instruments are considered, together with the methods of calibration.

Reference books: *Electrical Measurements*—Laws. *Basic Electrical Measurements*—Stout.

715. Electric Circuits. A. J. Kravetz.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Circuits as models for physical devices. Kirchhoff's laws. Transient response of circuits. Steady state response of circuits with sinusoidal excitation. Network theorems. Topology and loop and nodal analysis of general circuits. Complex frequency analysis of circuits. Response of circuits to variable-frequency excitation. Analysis of polyphase circuits. Magnetically coupled circuits.

716. Electric Circuits Laboratory.

Course 5, II Year; 3 hrs. laboratory alternate weeks, both terms.

Laboratory exercises to accompany subject 715.

Ten laboratory reports.

717. Alternating-Current Circuits. W. Janischewskyj, I. McCausland.

Courses 1, 2 and 9, II Year; 2 hrs. lectures per week, first term.

Courses 3 and 4, II Year; 2 hrs. lectures per week, second term.

Fundamentals of alternating current, voltage and power. The analysis of series, parallel and three-phase circuits containing resistance, inductance and capacitance.

718. Alternating-Current Circuit Laboratory.

Courses 1, 2 and 9, II Year; 3 hrs. laboratory alternate weeks, first term.

Courses 3 and 4, II Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory exercises to accompany subject 717.

719. Electrical Engineering. F. A. Mason.

Courses 6 and 8, II Year; 2 hrs. lectures per week, both terms.

Basic d.c. measurements. Principles of single-phase and three-phase alternating currents. Elementary transients. Basic a.c.

measurements. Principles of operation of d.c. and a.c. machines. Introduction to electronics.

Textbook: *Basic Electrical Engineering*—Fitzgerald and Higginbotham.

720. Electrical Laboratory.

Courses 6 and 8, II Year; 3 hrs. laboratory per week, both terms.

Laboratory experiments to accompany subject 719.

Ten laboratory reports.

732. Applied Mathematics. P. P. Biringer.

Course 7, III Year; 2 hrs. lectures per week, both terms; 2 hrs. computation per week, both terms.

Vector analysis; functions of a complex variable, with applications; numerical analysis.

733. Electric Circuits II. V. G. Smith.

Course 7, III Year; 3 hrs. lectures per week, both terms.

Loop and nodal equations and methods of solution. Matrix notation. General theorems. Input and transfer admittances and impedances and dimensionless transfer functions. Symmetrical component analysis. Fourier series and integrals. Fourier and Laplace transforms, direct and inverse. Operational methods applied to transients in linear systems. Dependent sources. Two-port networks. Electrical filters.

734. Electric Machinery I. A. Straughen.

Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Processes for the electro-mechanical conversion of energy. The fields, forces and torques in singly and multiply excited magnetic systems. Theory, characteristics and applications of direct-current machines. Introduction to the dynamic behaviour and control of machines. Theory and applications of transformers. Introduction to rotating magnetic fields.

Reference books: *Electric Machinery*—Fitzgerald and Kingsley. *Principles of Direct-Current Machines*—Langsdorf. *Direct-Current Machinery*—Kloeffler, Brenneman, and Kerchner.

735. Electrical Laboratory.

Course 7, III Year; 3 hrs. laboratory per week, both terms.

Laboratory exercises to accompany subjects 733 and 734.

736. Electrical Problems and Seminar.

Course 7, III Year; 4 hrs. per week, both terms.

Problems associated with courses 733, 734 and 737 are worked out under staff supervision. To provide practice in public speaking, one hour per week in the second term is devoted to short talks and discussions by the students on topics of their own choice.

737. Electronics. J. E. Reid.

Course 7, III Year; 2 hrs. lectures per week, first term; 3 hrs. lectures per week, second term.

The behaviour of charged particles in electromagnetic fields. Electrical conduction in solids and gases. Electron emission. Semiconductor and vaccum devices. Electronic circuits.

738. Electronics Laboratory.

Courses 5a, 5e, 5p and 7, III Year; 3 hrs. laboratory per week, second term.

Laboratory experiments to accompany subjects 737 and 739. Five laboratory reports.

739. Electronics. E. S. Lee.

Courses 5a, 5e, 5p, III Year; 2 hrs. lectures per week, both terms.

Introduction to electrodynamics and electrical conduction in solids and gases. Physical principles of electron devices. Linear and non-linear circuits using electron devices.

740. Electronics. I. R. Dalton.

Courses 5c, 5g, III Year; 2 hrs. lectures per week, both terms.

Physical principles of electronic devices and their applications in linear and non-linear circuits. Simple instrumentation and control systems.

741. Electronics Laboratory.

Courses 5c, 5g, III Year; 1½ hrs. laboratory per week, second term. Laboratory experiments to accompany subject 740.

Five laboratory reports.

742. Circuit Analysis. J. L. Yen.

Course 5e, III Year; 2 hrs. lectures per week, both terms.

Advanced analytical methods are used to derive general network theorems and to discuss general network properties. Complex wave forms, filters and unbalanced polyphase networks are considered in detail.

743. Electronics. P. E. Burke.

Courses 3 and 4, III Year; 2 hrs. lectures per week, first term.

Properties of vacuum tubes, gas tubes and semiconductors and their use as rectifiers and modulating devices. The use of circuit models containing ideal diodes and ideal controlled sources in analysing rectifiers and modulating devices.

744. Electronics Laboratory.

Courses 3 and 4, III Year; 3 hrs. laboratory alternate weeks, first term.

Laboratory exercise to accompany subject 743.

Four laboratory reports.

745. Electric Machines. P. P. Biringer.
Course 5e, IV Year; 2 hrs. lectures per week, both terms.
Theory and applications of transformers, direct-current and alternating-current machines. Non-linear power modulators.

746. Electric Machines Laboratory.
Course 5e, IV Year; 3 hrs. laboratory alternate weeks, both terms.
Laboratory experiments to accompany subject 745.

747. Electric Machines. F. A. Mason.
Course 3, III Year; 2 hrs. lectures per week, both terms.
Operating characteristics, control, and applications of direct-current and alternating-current machines.

748. Electric Machines Laboratory.
Course 3, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.
Laboratory exercises to accompany subject 747.
Seven laboratory reports.

760. Electric Machines. W. Janischewskyj.
Course 4, IV Year; 2 hrs. lectures per week, first term.
Operating characteristics and applications of transformers and rotating electric machines.

761. Electric Machines Laboratory.
Course 4, IV Year; 3 hrs. laboratory per week, first term.
Laboratory exercises to accompany subject 760.
Four laboratory reports.

762. Electromagnetic Engineering. G. Sinclair.
Course 7, IV Year; 2 hrs. lectures per week, both terms; 2 hrs. computation alternate weeks, both terms.
Maxwell's equations, wave equations, retarded potentials, reciprocity theorem, lumped and distributed circuits, transmission lines under transient and steady-state conditions, impedance charts, matching, waves in rectangular and circular waveguides, radiation from linear antennas, arrays, Friis transmission formula.

763. Electric Machinery II. G. F. Tracy.
Course 7, IV Year; 3 hrs. lectures per week, first term.
The theory and performance of generators, synchronous motors, single and polyphase induction motors.
Reference books: *Principles of Alternating Current Machinery* —Lawrence. *Alternating Current Machines*—Puchstein and Lloyd. *Electrical Machinery*—Fitzgerald and Kingsley.

764. Electric Machines Laboratory.
Course 7, IV Year; 3 hrs. laboratory per week, first term.
Laboratory exercises to accompany subject 763.
Four laboratory reports.

765. Control Systems. J. M. Ham.

Course 7, IV Year; 2 hrs. lectures per week, both terms.

A study of the analysis and synthesis of linear feedback control systems by means of differential equations and the Laplace transform. Topics covered include stability criteria, root-locus methods and compensation methods. An introductory study of non-linear systems is also made, including the use of describing-function and phase-plane methods of analysis.

766. Control Systems. J. M. Ham.

Courses 5e and 5n, IV Year; 2 hrs. lectures per week, both terms.

A course in linear and non-linear control systems that is similar to subject 765 but adapted to the needs of Courses 5e and 5n.

767. Control Systems Laboratory.

Courses 5e, 5n and 7, IV Year; 3 hrs. laboratory alternate weeks, both terms.

Laboratory experiments and design problem periods to accompany subjects 765 and 766.

Four laboratory reports.

768. Electronic Circuits. J. E. Reid.

Courses 5e, 5p and 7, IV Year; 3 hrs. lectures per week, first term.

The basic principles of amplification, detection, modulation, demodulation, and radio-frequency power generation.

Reference book: *Applied Electronics*—Gray.

769. Electronic Circuits Laboratory.

Courses 5e, 5p and 7, IV Year; 3 hrs. laboratory per week, first term.

Experiments and problems to accompany subject 768.

Six laboratory reports.

770. Communication Systems. J. E. Reid.

Courses 5e and 7, IV Year; 3 hrs. lectures per week, second term.

A continuation of subject 768 covering theory and design of Class B and C amplifiers, power oscillators, crystal oscillators. Noise in communication circuits. Frequency conversion. Impedance transformation.

Reference book: *Applied Electronics*—Gray.

771. Communications Laboratory.

Courses 5e and 7, IV Year; 3 hrs. laboratory per week, second term.

Experiments and problems to accompany subject 770.

Seven laboratory reports.

772. Operational Methods. V. G. Smith.

Courses 5e, 5n and 5t, IV Year; 2 hrs. lectures per week, both terms.

Classical and Heaviside's operational methods are developed. Fourier's methods leading to the Laplace transforms are discussed and the close relationship between Laplace and Heaviside emphasized. Applications are chiefly to electric circuit analysis.

Reference books: *Transformation Calculus and Electric Transients*—Goldman. *Electromagnetic Theory*—Heaviside. *Transients in Linear Systems*—Gardner and Barnes. *Simple Calculation of Electrical Transients*—Carter.

773. Applied Electromagnetic Theory. G. Sinclair.

Courses 5e, 5g, 5n and 5p, IV Year; 2 hrs. lectures per week, both terms.

The theory of transmission lines under transient and steady-state conditions, the basic theory of electric and magnetic fields, Maxwell's Equations, waves in rectangular waveguides, and radiation from linear antennas and arrays. Interaction of fields and charged particles, generation and detection of microwave energy.

774. Electric Machinery III. G. F. Tracy.

Course 7, IV Year; 2 hrs. lectures per week, second term.

A continuation of subject 763. Special types of alternating current motors, synchronous converters, single-phase induction motors, frequency changes, selsyn devices.

775. Electric Machines Laboratory.

Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory exercises to accompany subject 774.

Three laboratory reports.

776. Microwave Engineering. J. L. Yen.

Course 7, IV Year; 2 hrs. lectures per week, second term.

The generation, processing, transmission and detection of microwaves and their applications.

777. Microwave Engineering Laboratory.

Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory exercises to accompany subjects 773 and 776.

779. Electric Power Systems. W. Janischewskyj.

Course 7, IV Year; 3 hrs. lectures per week, second term.

The theory associated with the economic generation, transmission and distribution of electrical energy in bulk and the control of power systems under normal and fault conditions.

780. Electric Power Systems Laboratory.

Course 7, IV Year; 3 hrs. laboratory exercises and problems per week, second term, to accompany subject 779.

781. Computer Logic and Design. E. S. Lee.
Course 7, IV Year; 1 hr. lecture per week, both terms.
An introduction to the logical structure and electronic circuits of digital computers.

782. Logic Circuits. E. S. Lee.
Course 5e, IV Year; 2 hrs. lectures per week, second term.
Boolian algebra applied to electric switching networks. Solid state circuits for performing elementary logical operations. Computer applications.

790. Acoustics. V. L. Henderson.
Course 5e, IV Year; 1 hr. lecture per week, both terms.
Acoustics of electrical sound systems; including sound waves hearing, the mechanical-electrical-acoustical analogy, microphones, loud speakers, etc.
Reference book: *Elements of Acoustical Engineering*—Olson.

791. Acoustics Laboratory.
Course 5e, IV Year; 1½ hrs. laboratory per week, second term.
Supplementary subject 790.

792. Acoustics. V. L. Henderson.
Course 7, IV Year; 2 hrs. lectures per week, second term.
This subject deals with the properties of acoustical elements, particularly with their application in electrical sound systems.
Reference book: *Elements of Acoustical Engineering*—Olson.

793. Acoustics Laboratory.
Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.
Supplementing subject 792.
Three laboratory reports.

794. Illumination. Miss M. G. Currie, J. Chisvin.
Course 7, IV Year; 2 hrs. lectures per week, second term.
Illuminating Engineering dealing with the nature, measurement, and production of light and related radiations.
Theory of human vision; the design and application of lighting equipment for visual efficiency and comfort. Fundamentals of power supply.

795. Illumination Laboratory.
Course 7, IV Year; 3 hrs. alternate weeks, second term.
Supplementing subject 794.
Three laboratory reports.

798. Vibration Engineering. V. L. Henderson.
Course 5t, IV Year; 1 hr. lecture per week, both terms.
Vibrating systems with one degree of freedom. Electrical analogues and impedance methods. Systems with more than one dergee of freedom. Application to machines and structures. Instrumental methods.

799. Vibration Laboratory.

Course 5t, IV Year; 3 hrs. laboratory per week, second term.

A series of experiments designed to give familiarity with the nature of vibrating systems and the causes, measurements, and control of vibration in engineering problems.

Three laboratory reports.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

801. Materials Processing I. L. M. Pidgeon, H. U. Ross.

Course 8, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

High temperature systems, furnaces, fuels, refractories and pyrometry.

802. Chemistry of Metals. L. M. Pidgeon.

Courses 5m and 8, III Year; 1 hr. lecture per week, both terms.

A fundamental treatment of the metallurgical processes involved in the production of the important non-ferrous metals, including oxidation of sulphides in the liquid and solid states, reduction of oxides, matte-slag equilibrium, metal-slag equilibrium, and the distillation of metals.

803. Chemistry of Metals Laboratory. H. U. Ross.

Course 8, III Year; 3 hrs. laboratory per week, first term; 6 continuous hrs. laboratory per week, second term.

Experiments in materials processing, including roasting, smelting, leaching, refining, electrolysis to accompany Subjects 802 and 833. Eight laboratory reports per term.

804. Metallurgy. H. U. Ross.

Courses 2 and 9, III Year; 1 hr. lecture per week, second term.

An introductory course describing the theory and practice of metallurgical processes and operations.

805. Chemistry of Metals. L. M. Pidgeon, H. U. Ross.

Courses 5m and 8, IV Year; 2 hrs. lectures per week, both terms.

The extractive metallurgy of iron, steel, and the reactive metals.

806. Chemistry of Metals Laboratory. H. U. Ross.

Course 8, IV Year; 6 continuous hrs. laboratory per week, first term.

Experiments in the extraction and refining of metals and related processes to accompany Subject 805. Six laboratory reports per term.

808. Metallurgy. L. M. Pidgeon.

Courses 2 and 9, IV Year; 1 hr. lecture per week, both terms.

The extractive metallurgy of the common metals, together with the calculations necessary to understand metallurgical processes.

809. Metallurgy Laboratory. H. U. Ross.
Course 2, IV Year; 6 hrs. continuous laboratory per week for one half of second term.
Similar to subject 803.
One laboratory report per week.

810. Thermodynamics in Metallurgy. S. N. Flengas.
Course 8, III Year; 2 hrs. lectures per week, both terms.
The physico-chemical principles of metallurgy, properties of matter in the condensed states.

811. Materials Processing Laboratory. H. U. Ross.
Course 8, II Year; 3 hrs. laboratory per week, second term.
Experiments and problems in pyrometry, furnaces, refractories, fuels and instruments to accompany Subject 801. Eight laboratory reports for the term.

812. Metalurgical Problems Laboratory. S. N. Flengas, H. U. Ross.
Course 8, III Year; 4 hrs. laboratory per week, both terms.
Problems in chemistry, physical chemistry and thermodynamics as applied to metallurgical processes, and solid state reactions relating to Subjects 802 and 810.

813. Thermodynamics in Metallurgy. S. N. Flengas.
Course 8, IV Year; 2 hrs. lectures per week, both terms.
A study of chemical equilibria at high temperatures in extractive metallurgy. Slag-metal reactions—phase diagrams. Quasichemical approach to the theory of solutions—corrosion.

814. Metallurgical Problems Laboratory. S. N. Flengas.
Course 8, IV Year; 2 hrs. lectures per week, both terms.
Problems relating to subjects 805, 807 and 813.

815. Physical Metallurgy. G. B. Craig.
Course 1, II Year; Course 2, IV Year; 2 hrs. lectures per week, second term.
A course on the structure and mechanical properties of metals and alloys and on the influence of heat and mechanical treatment upon these properties. Reference is made particularly to steels and the more-important non-ferrous alloys. Welding of metals is also included.

816. Physics of Metals. A. Plumtree.
Courses 5c, 5n, IV Year; 1 hr. lecture per week, both terms.
A course on the physics of metals to include the structure of solids, defects in the solid state, diffusion, the effects of stress and temperature upon metals, and the relationship between structure and properties.

817. Physical Metallurgy. W. C. Winegard.
Courses 3 and 4, II Year; 2 hrs. lectures per week, both terms.

A general course in Physical Metallurgy, dealing with the structure of metals and alloys, with special reference to the ferrous alloys of practical importance. The influence of mechanical deformation, heat treatment, and composition on the structure is considered, and the relation between the structure and mechanical porperties is examined.

818. Physical Metallurgy Laboratory. W. C. Winegard.
Courses 3 and 4, II Year; 3 hrs. laboratory per week for six weeks, second term.
A practical course illustrating the principles dealt with in subject 817. Experiments are conducted on the heat-treatment of ferrous and non-ferrous alloys.

819. Physics of Metals. A. Plumtree.
Courses 5e and 7, III Year; 2 hrs. lectures per week, second term.
A course on the physics of metals to include structure of solids, defect structures, diffusion, electron theory, phase transformations, and the effect of stress and temperature upon metals.

820. Physics of Metals Laboratory. A. Plumtree.
Course 7, III Year; 1½ hrs. laboratory per week, second term.
Experiments are conducted to illustrate the essential features of Subject 819. These include the examination of metals by metallographic and X-ray diffraction techniques.

821. Physics of Metals. G. B. Craig and W. C. Winegard.
Courses 5m, 8, III Year; 2 hrs. lectures per week, both terms.
A discussion of the structure of solids with particular reference to X-ray methods of investigation; the solidification of metals, and the plastic deformation of metals with reference to the dislocation theory.

822. Physics of Metals Laboratory. W. C. Winegard.
Courses 5m and 8, III Year; 6 hrs. laboratory per week, first term; 3 hrs. laboratory per week, second term.
Practical work relating to Subject 821.

823. Physics of Metals. G. B. Craig and W. C. Winegard.
Courses 5m and 8, IV Year; 2 hrs. lectures per week, both terms.
Transformations which occur in alloys, diffusion, electron theory, surface reactions.

824. Physics of Metals Laboratory. G. B. Craig.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms; 3 hrs. laboratory per week, second term.
Practical work relating to Subject 823.

826. Chemistry and Physics of Materials Seminar. Staff in Metallurgy.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms.

Each student prepares and presents seminars on topics concerning chemistry and physics of materials.

827. Chemistry and Physics of Materials Laboratory. Staff in Metalurgy.
Course 5m, IV Year; 12 hrs. per week, both terms.
The design and execution of one or more experiments on a topic of current interest in the field of chemistry and physics of materials.

829. Chemistry of Metals Laboratory. H. U. Ross.
Course 5m, III Year; 4 hrs. per week, second term.
Experiments designed to illustrate the principles underlying the high temperature reactions which are encountered in the production and refining of metals.

830. Metallurgical Thermodynamics. S. N. Flengas.
Course 5m, III Year; 1 lecture per week, both terms.
Chemical equilibria at high temperatures in extractive metallurgy. Condensed states of matter—quasichemical approach to the theory of solutions—slag theories—metallic solutions—slag/metal equilibria—kinetics of metallurgical processes.

831. Metallurgical Thermodynamics Problems. S. N. Flengas.
Course 5m, III Year; 2 hrs. per week, both terms.
Problems relating to Subject 830.

832. Physics and Chemistry of Materials. Staff in Chemical Engineering, Civil Engineering, Electrical Engineering and Materials Science.
Courses 5m, 8, III Year; 2 hrs. lectures per week, both terms.
A course on the structure and properties of plastics, glass, ceramics, semi-conductors, and concrete.

833. Materials Processing II. H. U. Ross.
Course 8, III Year; 1 hr. lecture per week, both terms.
The theory and practice of processing metallic and non-metallic materials, including the relevant aspects of mineralogy, surface chemistry, physical separation, calcining, roasting, sintering and leaching.

INSTITUTE FOR AEROSPACE STUDIES

1028. Fluid Mechanics. D. E. Rothe.
Course 5a, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.
Introductory concepts; mathematical theory of inviscid flow, incompressible and compressible; viscous flow and turbulence.

1029. Fluid Mechanics Laboratory. D. E. Rothe, B. Etkin, J. B. French.
Course 5a, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.
Problems and experiments related to subject 1028. Seven laboratory reports.

1030. Advanced Mechanics. H. S. Ribner.

Course 5, III Year; 2 hrs. lectures per week, both terms.

Mechanics of particles: fixed axes, rotating and moving axes, orbital dynamics, rockets. Mechanics of rigid bodies: fixed axes, body-attached axes, gyroscopes. Mechanics of linear systems: free and forced oscillations, coupled systems, waves on a string. Rayleigh's method. Lagrange's equations. Introduction to special relativity.

Reference books: *Introduction to Theoretical Physics*—Page. *Principles of Mechanics*—Synge and Griffith. *Dynamics*, Vols. I and II, Halfman.

1034. Mechanics of Structures. R. C. Tennyson.

Course 5a, III Year; 2 hrs. lectures per week, both terms.

Bending and torsion of thin web beams and shells. Analysis of indeterminate structures using energy theory. Instability of columns and plates. Plane stress problems; the Airy and Prandtl stress functions.

Reference books: *Aircraft Structural Mechanics*—Steinbacker and Gerard. *Elasticity in Engineering*—Sechler.

1035. Mechanics of Structures Laboratory. R. C. Tennyson.

Course 5a, III Year; 3 hrs. laboratory per week, first term; 1½ hrs. per week, second term.

Problems and experiments relating to subject 1034. Five laboratory reports.

1040. Aerodynamics. B. Etkin.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Aerodynamics of flight: drag, propulsion, wing theory. Mechanics of flight: performance of aircraft, stability and control of aircraft.

Reference books: *Aerodynamics for Engineering Students*—Houghton and Brock. *Foundations of Aerodynamics*—Kuethe and Schetzer. *Flight Mechanics—1: Theory of Flight Paths*—A. Miele. *Dynamics of Flight—Stability and Control*—Etkin.

1041. Aerodynamics Laboratory. B. Etkin.

Course 5a, IV Year; 3 hrs. laboratory per week, second term.

Problems and experiments related to subject 1040.

Five laboratory reports.

1042. Engineering Design. R. D. Hiscocks.

Course 5a, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

An introduction to the principles of design; the origin of a design requirement; loading, performance and other criteria; typical design specifications.

The process is examined by which the design is synthesized from the design specification and various other related data.

Selection of material; type of structure and fabrication technique.

Certain important aspects of design are examined in detail. These include the design of riveted, bolted, glued and welded joints, the design of cast and forged structural components, the fatigue life of structures and "fail safe" principles.

The course is illustrated throughout by reference to typical design problems, some of which are solved by the students.

1043. Engineering Design Laboratory. R. D. Hiscocks.

Course 5a, IV Year; 3 hrs. laboratory per week, both terms.

Design projects based on the lectures in subject 1042 are assigned. Design drawings, and engineering reports are prepared by the students.

1044. Mechanics of Solids and Structures. R. C. Tennyson.

Course 5a, IV Year; 1 hr. lecture per week, both terms.

A continuation of subject 1034 to a more advanced level; structural stability; thermal stresses; structural vibrations and wave propagation.

Reference books: *Elasticity in Engineering*—Sechler. *Inelastic Behaviour of Engineering Materials and Structures*—Freudenthal.

1045. Mechanics of Solids and Structures Laboratory. R. C. Tennyson.

Course 5a, IV Year; 3 hrs. laboratory per week, first term.

Problems and experiments related to subject 1044.

Six laboratory reports.

1046. Plasmadynamics. J. H. deLeeuw.

Course 5a, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Review of electric and magnetic fields. Derivation of Maxwell's equations. Thermodynamics and equations of motion of an electrically conductive medium. Simple examples of the influence of a magnetic field on the motion of an electrically conductive medium.

1047. Plasmadynamics Laboratory. J. H. deLeeuw, J. B. French.

Course 5a, IV Year; 3 hrs. laboratory alternate weeks, second term.

Problems and experiments based on the lecture material of subject 1046.

Two laboratory reports.

1048. Gasdynamics. I. I. Glass.

Courses 5a and 5t, IV Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Introductory thermodynamics of perfect and imperfect gases; equations of motion and their applications to nozzles, diffusers, shock tubes, and shock tunnels; expansion waves and normal

and oblique shock waves in perfect and imperfect gases; shock and expansion wave interactions.

Reference books: *Elements of Gasdynamics*—Liepmann and Roshko. *Dynamics and Thermodynamics of Compressible Fluid Flow*—Shapiro. *Handbook of Supersonic Aerodynamics, Section 18, Shock Tubes*—Glass and Hall.

1049. Gasdynamics Laboratory. I. I. Glass, J. B. French.

Courses 5a and 5t, IV Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.

Problems and experiments based on subject 1048 are given to illustrate principles of gasdynamics and the measurement of physical quantities.

Six laboratory reports.

1050. Transport Phenomena. J. B. French.

Course 5a, IV Year; 1 hr. lecture per week, both terms.

A fundamental treatment of selected phenomena in fluid dynamics in which the transport of momentum, mass and energy are the key underlying processes, i.e. dynamics of viscous fluids; boundary layers; diffusion.

Reference book: *Transport Phenomena*—Bird, Stewart and Lightfoot.

1052. Applied Mathematics. S. J. Townsend.

Course 5a, III Year; 1 hr. lecture per week, both terms.

Application of the theory of functions of a complex variable to conformal mapping and contour integration. Examples are drawn from aerodynamic theory and theory of the control of flight vehicles.

DEPARTMENT OF PHILOSOPHY

2040. Philosophy of Science. Marcus Long, C. W. Webb.

Courses 1, 2, 3, 4, 5, 6, 7, 8, and 9, IV Year; 2 hrs. lectures per week, first term.

The relation between Science and Philosophy; an examination of the presuppositions of science and its basic concepts; alternative accounts of the nature of the universe with their implications for social and moral behaviour.

DEPARTMENT OF ENGLISH

2110. English.

All courses, I Year; 2 hrs. lectures per week, both terms.

A course in essay writing and the reading of literary works. Texts will include: Altick, *Preface to Critical Reading* (Holt, Rinehart), Kazin, *The Open Forum* (Harcourt Brace); Swift, *Gulliver's Travels* (Modern Library College), Orwell, *Animal Farm* (Penguin), Waugh, *The Loved Ones* (Dell); Shakespeare,

Twelfth Night (Ginn), Goldsmith, *She Stoops to Conquer* (Crofts *Classics*), Synge, *Playboy of the Western World* in *Plays, Poems and Prose* (Dent); an anthology of poetry to be announced in September.

2140. English Literature.

All courses, IV Year; 1 hr. lecture per week, both terms.

A course in the drama, the novel and poetry based on the study of the following texts: Shakespeare, *Othello* (Folger), Tennessee Williams, *Streetcar Named Desire* (Signet), O'Casey, *Juno and the Paycock* in *Three Plays* (St. Martin's Library), Shaw, *Back to Methuselah* (Penguin); Fielding, *Joseph Andrews* (Holt, Rinehart), Lawrence, *Sons and Lovers* (Penguin), Cary, *Horse's Mouth* (Universal Library); Oscar Williams, ed., *Little Treasury of Modern Poetry* (Scribners).

Students are expected to read the works named above during the summer preceding their entry into the Fourth Year. Term work will include assignments based on texts read during the summer, one substantial essay, and two class tests. Students who obtain a satisfactory term mark will not be required to write a final examination.

DEPARTMENT OF HISTORY

2330. Europe and the Modern World, 1500–1950. R. F. Harney.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An introduction to the main currents of European history between 1500 and 1950, and of European relations with the extra-European world. The purpose of the course is not merely the accumulation of factual information, but also the attainment of some understanding of historical processes affecting the forms of political organization, economic activity, intellectual and social movements.

Textbook: E. R. Tannenbaum, *European Civilization Since The Middle Ages* (John Wiley).

DEPARTMENT OF MATHEMATICS

2410. Calculus, Analytical Geometry and Algebra. R. A. Adams, C. Billigheimer, R. R. Burnside, T. M. K. Davison, W. N. Selander, S. H. Smith, P. Tan, J. R. Vanstone.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 3 hrs. lectures and 3 hrs. problems per week, both terms.

Real numbers and functions; limits, continuity and derivative functions; basic formulae of the differential calculus involving algebraic, trigonometric and exponential functions; applications to the sketching of curves, linear motion and rate problems. The definite integral and the fundamental theorem of the integral calculus, applied to the calculation of areas, volumes and work;

techniques of integration, change of variable, integration by parts. Euclidean geometry in two and three dimensions; linear algebra, vector spaces, scalar products, matrices and determinants; eigenvalues and the reduction of the equations of quadric surfaces to standard forms.

2415. Algebra and Geometry. D. A. Clarke, Miss M. Wonenburger.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

Complex numbers and fields. Polynomials. Linear Algebra: linear equations, vector spaces and linear transformations. Coordinate Geometry: lines, planes and surfaces of the second degree.

2416. Calculus. W. J. R. Crosby, D. K. Sen.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

An introduction to the theory and applications of differential and integral calculus.

Reference books: *Calculus*—Sherwood and Taylor. *Calculus*, Vol. I—Apostol.

2420. Calculus. B. Brainerd, P. B. Chapman, G. Tanyi, W. H. Williams.

Courses 1, 2, 3, 4, 6, 8, and 9, II Year; 2 hrs. lectures per week, both terms.

Continuation of subject 2410. Partial differentiation, multiple integration, series and Taylor's theorem, complex numbers and hyperboic functions, first order differential equations and higher order linear differential equations with constant coefficients. Problems dealt with in the drafting room as outlined in subjects 138, 143, 144 and 383.

2421. Calculus and Differential Equations. D. R. Breach.

Course 7, II Year; 2 hrs. lectures per week, both terms. 2 hrs. computation per week, both terms.

The definite integral, expansion in series, ordinary differential equations, partial differentiation, multiple integration and an introduction to partial differential equations.

2423. Probability and Statistics. W. R. Knight.

Courses 4 and 8, II Year; 2 hrs. lectures per week, both terms.

Frequency distributions and probability laws; binomial, Poisson, and normal distributions and the treatment of samples drawn from them; tests of significance and confidence limits; control charts; introduction to the analysis of variance; design of experiments; regression theory.

2424. Probability and Statistics Laboratory. W. R. Knight.

Courses 4 and 8, II Year; 2 hrs. laboratory per week, both terms.

Laboratory exercises associated with the material of the companion lecture subjects.

2425. Differential Calculus. W. J. R. Crosby, D. K. Sen.
Course 5, II Year; 2 hrs. lectures per week, both terms.
Ordinary and partial differentiation, differentials. Taylor's theorem for functions of one or more variables, maxima and minima, transformations, convergence and uniform convergence, differential equations of the first order, linear differential equations with constant coefficients.
Reference books: *Advanced Calculus*—Sokolnikoff. *Advanced Calculus*—Taylor.

2426. Integral Calculus. W. J. Webber, K. B. Ranger.
Course 5, II Year; 2 hrs. lectures per week, both terms.
Methods of indefinite integration, definite integrals, multiple integrals, line and surface integrals, orthogonal functions.
Textbook: *Advanced Calculus*—Sokolnikoff.

2427. Probability and Statistics. W. R. Knight.
Course 5, II Year; 2 hrs. lectures per week, both terms.
Definition of probability; binomial, Poisson, and normal distributions; frequency; sampling distributions. Examples of estimation, hypothesis testing, control charts, regression, and analysis of variance.

2428. Mathematical Problems, and Machine Computation. W. J. R. Crosby, W. R. Knight, K. B. Ranger, D. K. Sen, W. J. Webber.
Course 5, II Year; 3 hrs. problems per week, both terms.
A laboratory course: uses weekly problems based on the content of courses 2425, 2426, 2427 and provides an opportunity for informal discussion of topics presented in these courses. A portion of the time will be devoted to machine calculation.

2430. Probability and Statistics.
Course 4, III Year; 1 lecture per week, both terms.
A continuation of course 2423.
General regression theory; elements of the theory of sample surveys; an introduction to the theory of stochastic processes.

2431. Probability and Statistics Laboratory.
Course 4, III Year; 1½ hrs. per week, both terms.
Laboratory exercises based on the material of course 2430.

2432. Differential Equations. C. Davis, W. P. Kotorynski.
Courses 3, 4, and 8, III Year; 2 hrs. lectures per week, both terms.
First and second order ordinary differential equations, operational methods, variation of parameters, solution in series, Fourier series, Bessel and Legendre functions, the Laplace transform.

2433. Numerical Analysis. W. Kotze.
Course 4, III Year; 2 hrs. lectures per week, both terms.
Solution of algebraic equations, systems of linear equations,

eigenvalue problems, interpolation, approximation theory, numerical integration, random numbers.

Reference texts: *An introduction to Numerical Mathematics*—E. L. Stiefel. *Methods in Numerical Analysis*—Kaj L. Nielsen. *Numerical Methods for Science and Engineering*—R. G. Stanton.

2434. Numerical Analysis Laboratory. W. Kotze.

Course 4, III Year; 3 hrs. laboratory per week, both terms.

Practice in the numerical analysis methods and techniques dealt with in the lecture subject. Practical problems, as well as problems of a fundamental mathematical nature, will be covered.

2436. Numerical Methods. W. Fraser.

Course 5c, III Year; 2 hrs. lectures per week, both terms.

Linear algebra, matrix inversion and eigenvalues, the solution of equations, iterative methods and interpolation, numerical differentiation and integration, the numerical solution of differential equations.

2437. Theory of Functions. W. H. Greub.

Courses 5e, 5g, 5m, 5n, 5p, 5t, III Year; 2 hrs. lectures per week, both terms.

Complex numbers, limits and series, analytic functions, Cauchy's theorem, Taylor and Laurent series, singularities and their significance, analytic continuation, contour integration, conformal mapping of one plane region on another.

Textbooks: *Functions of a Complex Variable*—Phillips. *Theory of Functions*—Copson. *Theory of Functions as Applied to Engineering Problems*—Rothe, Ollendorf, and Pohlhausen. *Introduction to Complex Variables and Applications*—Churchill.

2438. Differential Equations. S. H. Smith.

Course 5, III Year; 2 hrs. lectures per week, both terms.

First order equations solvable by quadratures, the linear equation of general order, operator methods, simultaneous linear equations, Sturn-Liouville systems.

Textbook: *Ordinary Differential Equations*—Kaplan.

2442. Statistics. P. Tan.

Course 8, IV Year; 2 hrs. lectures per week, second term.

An introduction to the statistical methods used in the analysis and control of production processes.

2445. Differential Equations of Mathematical Physics. G. F. D. Duff.

Courses 5a, 5e, 5g, 5m, 5n, 5p, 5t, IV Year; 2 hrs. lectures per week, both terms.

The underlying theory and important particular equations, including eigenvalues and eigenfunctions, Fourier integrals, spherical and cylindrical harmonics, vibration of strings, membranes, and rods, sound waves, equation of heat conduction.

Textbook: *Partial Differential Equations of Mathematical Physics*—Webster.

DEPARTMENT OF PHYSICS

2501. The Structure and Properties of Matter. J. N. P. Hume, R. J. Balcombe, J. D. Prentice, R. E. Pugh, B. P. Stoicheff.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

An introduction to the mechanical, electrical, magnetic, thermal and optical properties of matter in terms of atoms.

2502. Physics Laboratory. The Staff in Physics, Civil Engineering and Electrical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year.

Twenty-four 3-hour periods of laboratory or problem work, twelve of which are devoted to experiments in the Physics Laboratory, six to experiments in the Electrical Laboratory and six to problems in Applied Mechanics.

All work must be completed within the assigned laboratory hours.

2511. Properties of Matter, Mechanics and Heat. D. G. Ivey.

Course 5, I Year; 3 hrs. lectures per week, both terms.

Textbook: *Mechanics, Heat and Sound*—Sear.

2512. Physics Laboratory. D. G. Ivey and the staff in Physics.

Course 5, I Year; 3 hrs. laboratory per week, both terms; 1 hr. tutorial per week, both terms.

To accompany subject 2511.

2521. Physics. J. N. P. Hume.

Course 5, II Year; 3 hrs. lectures per week, both terms.

Fundamental theory of electricity and magnetism. Electromagnetic waves. Interference, diffraction and polarization of light waves. Elementary atomic physics.

2522. Physics Laboratory. J. N. P. Hume.

Course 5, II Year; 3 hrs. laboratory per week, both terms.

To accompany subject 2621.

2525. The Physical Principles of Heat and Optics. R. Richmond.

Course 1, II Year; 2 hrs. lectures and 1½ hrs. laboratory per week, first term.

Course 8, II Year; 2 hrs. lectures and 3 hrs. laboratory per week, first term.

Thermal expansion, capacity, conductivity; radiation laws. Reflection, refraction, dispersion. Lens systems and optical instruments. Polarising and phase microscopes, interference, diffraction, coherence, optical masers.

Textbooks: *Heat and Sound*—Sears. *Optics*—Sears.

2526. Physics—Heat and Optics. A. D. Misener.

Course 7, II Year; 2 hrs. lectures and 3 hrs. Laboratory per week, second term.

Thermal expansion, capacity, conductivity and radiation including Planck's law, Wien's law, Stefan's law, Boltzmann distribution, thermal energy of particle, phonons. Basic concepts of reflection, refraction, dispersion and diffraction.

2531. Thermodynamics and Statistical Physics. J. C. Stryland.

Courses 5a, 5e, 5g, 5nt, 5p, III Year; 2 hrs. lectures per week, both terms.

The fundamental principles of thermodynamics, kinetic theory and statistical mechanics.

2532. Physics Laboratory. J. C. Stryland, H. P. Gush.

Courses 5a, 5e, 5g, 5nt, 5p, III Year; 3 hrs. laboratory per week, both terms.

To accompany subjects 2531, 2533 and 2534.

2533. Atomic Structure and Quantum Physics. H. P. Gush.

Courses 5a, 5e and 5p, III Year; 2 hrs. lectures per week, both terms.

Waves and particles; Schrodinger equation; harmonic oscillator, hydrogen atom, many-electron atoms; nuclear structure; radioactivity; interaction of radiation with matter.

2534. Physics of Solids and Fluids. R. List.

Courses 5e, 5m, 5p, III Year; 1 hr. lecture per week, both terms.

Elasticity, viscosity, equations of fluid motion, wave propagation, heat conduction, potential theory.

2535. Atomic and Nuclear Physics. K. G. McNeill.

Course 5nt, III Year; 2 hrs. lectures per week, both terms.

Schrodinger equation, hydrogen atom, many electron atoms, radiactivity, nuclear structure, neutron physics, introduction to reactor theory, health physics.

2536. Physics of the Earth. G. D. Garland.

Course 5g, III Year; 2 hrs. lectures per week, both terms.

Seismology and the internal constitution of the earth; the gravitational field; the earth's magnetism and magnetic properties of rocks; radioactivity, geothermal heat and the age of the earth.

2541. Electromagnetic Radiation and Matter. H. L. Welsh.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Propagation of electromagnetic waves, polarization, diffraction, interference, dispersion, scattering. Absorption, spontaneous and stimulated emission, Einstein coefficients. Coherence, maser and laser action.

2542. Physics Laboratory. The Staff in Physics.

Course 5n, IV Year; 6 hrs. laboratory per week, first term, and 3 hrs. per week, second term.

Courses 5c and 5p, IV Year; 6 hrs. laboratory per week, both terms.

To accompany the lecture subjects 2541, 2544, 2545 and 2546.

2543. Molecular Physics and Statistical Mechanics. E. J. Allin and J. D. Poll.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Quantum theory of rotation and vibration of molecules. Nuclear spins, symmetry, intensity rules, the hydrogen molecule, intermolecular forces. Boltzmann theory, transport equations, the Gibbs method, partition functions.

2544. Nuclear and High Energy Physics. K. G. McNeill, L. E. H. Trainor.

Courses 5n, 5p, IV Year; 2 hrs. lectures per week, both terms.

Nuclear forces, alpha-decay, beta-decay. Excited states of nuclei. Nuclear models. Reaction theory. Mesons, anti-particles, hyperons.

2545. Quantum Mechanics. J. Van Kranendonk.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Schrodinger equation, eigenvalues and eigenfunctions. Angular momentum, Pauli spin theory, identical particles. Perturbation theory, transition probabilities. Scattering theory.

2546. Atomic Physics. Miss E. J. Allin, D. A. L. Paul.

Courses 5a, 5g, 5m and 5t, IV Year; 3 hrs. lectures per week, both terms.

Introduction to quantum theory, atomic, molecular and nuclear physics.

2561. Theory and Application of Geophysical Methods. F. S. Grant.

Course 5g, IV Year; 2 hrs. lectures per week, both terms.

A course on the mathematical theory of magnetic, electrical, seismic and gravitational methods in applied geophysics.

2562. Geophysics. F. S. Grant, G. F. West.

Course 5g, IV Year; 6 hrs. laboratory per week, both terms. To accompany subject 2661.

2568. Exploration Geophysics. R. M. Farquhar, G. D. Garland.

Course 9, IV Year; 1 hr. lecture per week, both terms.

An introduction to the physical principles underlying the important methods of geophysical prospecting. Particular attention is given to the seismic, gravitational, magnetic and electromagnetic methods.

Textbook: *Introduction to Geophysical Prospecting*—Dobrin.

2569. Geophysics. R. M. Farquhar.

Course 9, IV Year; 3 hrs. laboratory per week, both terms. To accompany subject 2668.

DEPARTMENT OF CHEMISTRY

2621. Inorganic Chemistry. E. A. Robinson.

Course 5, II Year (elective); 2 hrs. lectures per week, both terms.

General inorganic chemistry, stereochemistry, and related physical measurements. Bonding and molecular structure.

2622. Physical Chemistry. S. S. Danyluk.

Courses 6, 8 and 9, II Year; 2 hrs. lectures per week, both terms.

An introductory course in chemical thermodynamics with emphasis on the thermodynamics of phase equilibria.

2623. Chemistry. M. J. Dignam.

Course 7, II Year; 2 hrs. lectures per week, first term.

Inorganic Chemistry, with emphasis on the fundamental particles, atomic structure, the nature of the chemical bond and general structural chemistry.

2624. Analytical Chemistry Laboratory. F. E. Beamish.

Course 8, II Year; 3 hrs. laboratory per week, both terms.

Quantitative analysis.

Eight laboratory reports.

2631. Atomic and Molecular Structure. J. P. Valleau.

Courses 5c, 5m, III Year; 2 hrs. lectures per week, both terms.

To follow course 2621. The application of wave mechanics to some problems of atomic and molecular structure, and an introduction to statistical thermodynamics.

DEPARTMENT OF POLITICAL ECONOMY

2720. Economics. A. Kruger, B. D. Bixley, D. M. Nowlan, J. P. Warner.

All courses, II Year; 2 hrs. lectures per week, both terms.

An introduction to the study of Economics with special reference to the problems of the Canadian economy.

Students will be requred to submit at least one essay or book review as part of their term work. Those students who obtain a satisfactory term mark will not be required to write final examination.

2730. Political Science. B. Kovrig.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An introduction to the study of government with special reference to the problems of Canadian government.

Students will be required to submit at least one essay or book review as part of their term work. Those students who obtain a satisfactory term mark will not be required to write final examination.

2734. Accounting. W. C. Hebdon.

Course 4, III Year; 2 hrs. lectures per week, both terms.

Basic accounting principles and procedures, the preparation and interpretation of financial statements, cost accounting, and the use of accounting as a means of control.

DEPARTMENT OF PSYCHOLOGY

2840. Industrial Psychology. J. W. Macmillan.
Course 4, IV Year; 2 hrs. lectures per week, second term.
A series of lectures and discussions on some of the human problems in industry, including the selection, classification and training of personnel, performance evaluation and the relationships between motivation and productivity.

DEPARTMENT OF GEOLOGY

2900. Geology. P. A. Peach, F. W. Beales.
Courses 2 and 9, II Year; course 5g, III Year; 2 hrs. lectures per week, both terms.
The principles of geology.

2901. Geology Laboratory. P. A. Peach, F. W. Beales.
Courses 2 (part) and 9, II Year; course 5g (part), III Year; 3 hrs. laboratory per week, both terms.
A Laboratory course to accompany subject 2900.

2904. Geology of Canada. F. W. Beales.
Course 9, IV Year; 1 hr. lecture per week, both terms.
A reading survey of the physiography, historical geology, major structural features, and mineral deposits of the country.

2906. Engineering Geology. W. H. Gross.
Course 1, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.
An introduction course in geology with special reference to engineering problems.

2907. Engineering Geology Laboratory.
Course 1, II Year; 1 hr. per week, first term; 2 hrs. per week, second term.
Specimens, maps and sections to accompany subject 2906.

2910. Mineralogy. The staff in Geology.
Courses 2 and 9, II Year; course 5g, III Year; 2 hrs. lectures per week, both terms.
An introductory course in crystallography, mineralogy, and the common rocks.

2911. Mineralogy Laboratory. The staff in Geology.
Courses 2 and 9, II Year; course 5g, III Year; 3 hrs. laboratory per week, both terms.
A laboratory course to accompany subject 2910.

2912. Optical Mineralogy. P. A. Peach, D. H. Gorman.
Course 9, II Year; 2 hrs. laboratory per week, both terms.
Microscopic study of minerals.

2913. Descriptive Mineralogy. D. H. Gorman.
Course 9, III Year; 2 hrs. laboratory per week, both terms.
Continuation of the mineralogy of subject 2910.

2915. Ore Microscopy. D. H. Gorman.
Course 9, III Year; 3 hrs. laboratory per week, second term.
Identification of minerals in polished sections.

2916. Crystallography. E. W. Nuffield.
Courses 5p and 8, III Year; 1 hr. lecture per week, both terms.
Lattices, symmetry operations, point groups, space groups, crystal classes and forms, crystal as a three-dimensional diffraction grating.

2918. X-Ray Crystallography. E. J. Brooker.
Course 5m, IV Year; 2 hrs. lectures per week, second term.
X-Ray diffraction methods and their application in the study of crystalline materials.

2920. Petrology. P. A. Peach.
Course 9, III Year; 3 hrs. lectures per week, first term; 2 hrs. lectures per week, second term.
Microscopic petrography, classification and origin of rocks.

2921. Petrography Laboratory. P. A. Peach.
Course 9, III Year; 2 hrs. per week, both terms.
Microscopic petrography, to accompany subject 2920.
Textbook: *Optical Mineralogy*—Rogers and Kerr.
One laboratory report.

2924. Elementary Geochemistry. F. G. Smith.
Course 9, III Year; 2 hrs. lectures per week, both terms.
Covering the periodic table, distribution of the elements, states of matter, phase diagrams, natural hydrothermal solutions, weathering, and geochemical cycles.

2932. Stratigraphy and Sedimentation. F. W. Beales.
Course 9, III Year; 2 hrs. lectures per week, first term.
Description, classification and interpretation of sedimentary rocks and rock units.

2934. Glacial Geology and Ground Water. R. E. Deane.
Course 2, IV Year; 1 hr. lecture per week, both terms.
Pleistocene Geology. The formation and distribution of the drift deposits of North America, with emphasis on their economic importance.

2936. Pleistocene Geology. R. E. Deane.
Courses 1D and 9, IV Year; 2 hrs. lecture per week, both terms.
Study of the Pleistocene Deposits of North America and Europe.

2938. Palaeontology. M. A. Fritz.
Course 9, III Year; 2 hrs. lecture per week, both terms.

2939. Palaeontology Laboratory. M. A. Fritz.
Course 9, III Year; 2 hrs. per week, both terms.
Six laboratory reports.

2944. Precambrian Geology. W. W. Moorhouse.
Courses 2, 5g, and 9, IV Year; 2 hrs. lecture per week, first term.
Precambrian formations of Canada—their rocks, distribution, relationships and economic features.

2945. Precambrian Geology Laboratory. W. W. Moorhouse.
Courses 2 and 5g, IV Year; 1 hr. laboratory per week, first term.
Course 9, IV Year; 3 hrs. laboratory per week, both terms.
To accompany subject 2944.

2950. Structural Geology. J. B. Currie.
Courses 2 and 9, III Year; 1 hr. lecture per week, both terms.
Development of structures in sedimentary, igneous and metamorphic rocks of the earth's crust.
Textbook: *Structural Geology*—Billings.

2951. Structural Geology Laboratory. J. B. Currie.
Courses 2 and 9, III Year; 3 hrs. per week, both terms.
A study of methods employed in solving structural problems.
Laboratory course to accompany subject 2950.

2960. Mineral Deposits. W. H. Gross.
Courses 2, 5g and 9, IV Year; 2 hrs. lecture per week, both terms.
Theories of origin of mineral deposits and description of world's important mineral deposits.

2961. Mineral Deposits Laboratory. W. H. Gross.
Course 9, IV Year; 3 hrs. per week, second term.

2964. Petroleum Geology. J. B. Currie.
Courses 5g and 9, IV Year; 2 hrs. lecture per week, both terms.
The occurrence of petroleum and natural gas pools and geological conditions of oil and gas entrapment in sedimentary basins.

2965. Petroleum Geology Laboratory. J. B. Currie.
Courses 5g and 9, IV Year; 3 hrs. per week, second term.
Laboratory study of methods for structural and stratigraphic analysis of oil accumulation in a sedimentary basin.

2968. Mining Geology. G. B. Langford.
Courses 2 and 9, IV Year; 2 hrs. lecture per week, second term.
A course dealing with the application of geology to mining.
Reference book: *Mining Geology*—McKinstry.

2969. Mining Geology Laboratory. G. B. Langford.
Course 9, IV Year; 3 hrs. per week, first term.
Two laboratory reports.

2981. Stratigraphic and Sedimentary Field Work. F. W. Beales.
Course 9, III Year; 2 hrs. per week, first term.
Field work along the Niagara Escarpment.
Three laboratory reports.

2983. Petrological, Mineralogical and Structural Field Work.
Course 2, III Year: 7 days.
Course 9, III Year: 14 days.
A field camp in the Tweed area of Ontario. Laboratory work in the field complementing subjects 2920 and 2951.

2985. Geological Field Trips (Glacial Geology).
Courses 2 and 9, IV Year. Two trips.
During the fall, trips will be made to points of interest near Toronto.

2987. Geological Field Trips (Economic and Mining).
Course 9, IV Year. Two trips, each half day.
Trip to gypsum mine and cement plant.

SCHOOL OF BUSINESS

3030. Industrial Management. T. C. Graham.
Course 4, III Year; 2 hrs. lectures per week, both terms.
A study of the factors involved in the production and distribution of products or services. Consideration will be given to the general concepts of management, organization, leadership and industrial relations but major emphasis will be on work simplification, time and motion study, wage administration and controls of production, quality and costs.

3031. Industrial Management Laboratory. T. C. Graham.
Course 4, III Year; 3 hrs. laboratory per week, both terms.
Cases and problems to accompany the lecture subject.

DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION

3110. Physical Education.
All courses, I Year.
The University requires that each student in his or her first year at the University take a medical examination given by the University Health Service. In addition each first year student, unless exempted as provided below, must register for and satisfactorily complete a swim test and the required programme in Physical Education. Any student, unless exempted, who does not satisfactorily complete the Physical Education requirement BEFORE advancing to the second academic year of his or her course shall

either (1) register for and satisfactorily complete the requirement BEFORE the end of the second academic year of his or her course, OR (2) pay an additional fee of $50 to be assessed in February of the session in which he or she is registered in the second academic year.

Physical Education credits may be earned by participation in instructional classes, swimming and water safety classes, intercollegiate and intramural sports.

EXEMPTIONS

1. One year's satisfactory standing in Physical Education at this or any other University.
2. Admission by advanced standing to second or a higher year at this University (automatic exemption).
3. If age is 25 years or more.
4. Ex-Military service (Permanent Force).
5. Provisional acceptance by the U.N.T.D., C.O.T.C., or U.R.T.P. followed by satisfactory completion of one year's service.
6. Exemption by the University Health Service.
7. Special consideration.

TO CLAIM EXEMPTION—Report by October 31 to:

Men —Intramural office, Room 106, Athletic Wing, Hart House.
Women—Room 230, Benson Building, 320 Huron Street.

INSTITUTE OF COMPUTER SCIENCE

3331. Engineering Data Processing. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 2 hrs. lectures per week, second term.
A course in programming and coding for the digital computer.

3332. Engineering Data Processing Laboratory. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 3 hrs. laboratory per week, second term.
Practical work to accompany subject 3331.

3333. Engineering Data Processing. C. C. Gotlieb, R. W. P. Anderson.
Course 4, III Year; 1 hr. lecture per week, both terms.
A course in programming and coding for the digital computer.

3334. Engineering Data Processing Laboratory. C. C. Gotlieb, R. W. P. Anderson.
Course 4, III Year; 1½ hrs. laboratory per week, both terms.
Practical work to accompany Subject 3333.

SPECIAL LECTURERS

3440. Engineering Law. W. O. Chris. Miller.
Courses 1, 3, 4, 6, and 7, IV Year; 1 hr. lecture per week, first term.
A subject designed to co-ordinate the practice of engineering

and law. Consideration is given to the characteristics, advantages and disadvantages of companies, partnerships and sole proprietorships, the promotion, organization and financing of companies, the duties of employees to employers, the duties and liabilities of engineers, statutes applicable to engineering works, professional engineering associations, construction contracts, workmen's compensation, trade unions and industrial disputes.

Textbook: *Engineering Law*—Laidlaw and Young.

SCHOOL OF ARCHITECTURE

3540. Town and Regional Planning. M. Hugo-Brunt.

Course 1B, IV Year; 1 hr. lecture per week, both terms.

Town Planning principles both past and present. The role of the planner, the plan, local legislation, the central area, the neighbourhood, subdivision, the suburb, open space and the region, housing, road layout, services, industry, commerce and special uses.

3541. Town and Regional Planning. M. Hugo-Brunt.

Course 1B, IV Year; 3 hrs. practical work per week, both terms.

Studio work including exercises in survey, research and analysis, subdivision layout, and urban analysis. These are related to subject 3540.

SECTION IX. EXAMINATIONS

ANNUAL EXAMINATIONS

1. Annual examinations will be held in April except as provided in paragraph 2 below.

2. Annual examinations will be held at the beginning of the second term in subjects completed during the first term.

3. Promotion from one year to another is made on the basis of the student's weighted average in the annual examinations and laboratory and other term work. Subjects will be weighted according to the number of hours devoted to them, the hours assigned to laboratory subjects being given one half the weight of those in lecture subjects.

Pass standing and promotion to the next higher year will be granted to students who obtain a weighted average of 60% or greater in the work of the year.

4. The student's work is graded in the following manner:

On Overall Average		*On Individual Subjects*	
Marks	Standing	Marks	Grade
75 — 100%	I Class (Honours)	75 — 100%	I
66 — 74%	II Class	66 — 74%	II
60 — 65%	III Class	60 — 65%	III
Below 60%	Failure	50— 59%	Pass
		Below 50%	Failure or BL

5. A student who obtains the passing average of 60% or greater in the work of the year but who has failed to pass one or more subjects will receive a standing of BL (below the line) in such subjects, and will be promoted to the next higher year.

6. Honour standing will be granted to students who pass in all written and laboratory subjects and who obtain a weighted average of 75% or greater in the work of the year.

7. Honour graduate standing will be granted to students who obtain honours in the final year and in any one previous year.

8. A student who fails in the work of any year will be permitted, unless otherwise ineligible, to register in a subsequent session for the purpose of repeating the year, subject to the following conditions:

(a) Only one such repetition will be allowed in the student's entire undergraduate course. A failure in enginering or in a related course at any other institution will be counted in the same way as a failure in this Faculty.

(b) During any such repetition, the full programme of prescribed instruction must be taken.

(c) Second, Third, or Fourth Year work may be repeated in the session immediately following that in which the failure occurs.

(d) A student who fails in the work for the First Year but who

obtained an average of 50% or over will, provided he is otherwise eligible, be allowed to repeat the work of the year in the following Session. All other students who fail in the work of the First Year must remain out for one Session before re-applying. If a student withdraws on or before 15th February he may re-apply for admission the following Session.

Any student re-applying for admission to the First Year must file a new application (as outlined in Paragraph 5, Section V) with the Registrar of the University.

9. A student whose attendance at lectures or laboratories, or whose work is deemed by the Council of the Faculty to be unsatisfactory, may have his registration cancelled at any time by the Council of the Faculty.

10. A student should submit to Council immediately after its occurrence, evidence of any illness or mishap which occurs during the session; any petition for leniency on account of such incidents may be refused consideration if received after the third day following the last day of examinations.

11. A student will not be allowed to write any examinations if he has not paid all fees and dues for which he is liable at that time.

TERM EXAMINATIONS

Term examinations may be held in any subject and at any time at the discretion of the instructor, or by the order of the Council, and the results of such examination may, if the Council so decides, be incorporated with those of the annual examinations in the same subjects.

EXTRA-CURRICULAR ACTIVITIES AND ACADEMIC CREDIT

It is in general desirable for students to engage to a reasonable extent in extra-curricular activities in order that they may not become too narrowly professional in interests and outlook, but it will be obvious that no academic credit or consideration can be given for such activities. Some offices in student organizations require quite large amounts of time for the proper performance of the duties connected with them, and it is therefore strongly recommended that students, particularly those whose academic records are not high, consult a senior member of Staff before allowing themselves to be nominated for such offices.

SECTION X. MEDALS, PRIZES, SCHOLARSHIPS, BURSARIES AND FELLOWSHIPS

Through the generosity of friends of the University, governments and commercial organizations, encouragement has been given to both undergraduate and graduate work in the various branches of engineering study by the establishment of the scholarships, prizes, bursaries and medals listed in the following pages.

ADMISSION SCHOLARSHIPS AND BURSARIES

Ontario Students:

Scholarships and bursaries available to students entering the First Year are listed on pages 140 and 141. For full details concerning these awards, applicants should consult the Calendar of Admission Awards, which is available at Secondary Schools or from the Office of the Registrar, Simcoe Hall. Applications, which must be made through the Principal of the Secondary School, close on May 1 annually.

Non-Ontario Students:

All non-Ontario students should apply to the Awards Department, Office of the Registrar, Simcoe Hall, University of Toronto. A limited number of scholarships is reserved for students living outside the Province of Ontario, but as competition is keen such students must not count on receiving assistance but are advised rather to ensure that they have sufficient funds from their own government or from private sources to cover all probable expenses.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed on pages 141 to 148. Where it is necessary to make application for an award it is so stated in the description and particulars are given as to how the application should be made. In all other cases the award is made on the recommendation of the Faculty Council and no application is necessary.

GENERAL TERMS AND CONDITIONS

In order to be eligible for a medal, prize, scholarship, bursary, fellowship or other award granted solely upon standing obtained at an annual or special examination or upon an essay, or term work, or other academic rating, a candidate must obtain honours at such annual or special examination or upon such essay, term work, or other academic rating unless the terms of the award or medal specify that standing lower than honours may be accepted.

When an award or medal is granted upon standing obtained on part

of the work of any academic year the candidate must obtain standing but need not obtain honours in the work of the academic year as a whole, provided he obtains honours in the part concerned, unless the terms of the award or medal specify otherwise.

No medal, prize, scholarship, bursary, fellowship or other award will be granted to a candidate who is conditioned in any subject at an annual examination or in Physical Education unless the terms of the award or medal specify otherwise.

A candidate will not be permitted to receive more than one award in a session unless the statute establishing each of the awards concerned or the Calendar specifies otherwise. Only one of those marked by an asterisk may be held in any one year. A candidate who would, but for this provision, have received more than one award may have his name so published in the class lists.

A candidate who has spent two sessions in any year of an undergraduate course is not eligible to compete for any award at the annual examinations of that year.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes other than awards for graduate study and research, will be paid in one instalment as soon as possible after the granting of the awards.

All other awards will be paid (i) if of the value of $100 or less, in one instalment on November 20 and (ii) if of the value of more than $100 in two equal instalments, the first on November 20 and the second on January 20, in the session following the granting of the awards. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

The Senate may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance upon lectures and laboratory classes for one year. Further postponement may be permitted on application.

Name	Amount	Application required	Available only to a limited group or single course	See page
AVAILABLE TO STUDENTS ENTERING THE FIRST YEAR				
Alumni Association War Memorial Scholarships	$500	Yes	No	175
Alcan Scholarship	$500	Yes	No	149
J. P. Bickell Foundation Scholarships	$500	Yes	No	152
J. W. Billes Admission Scholarships	—	Yes	No	153

Name	Amount	Application required	Available only to a limited group or single course	See page
Dominion Magnesium Limited Bursary	$400	Yes	Yes	155
Dominion-Provincial Student Aid Bursaries, Type A	—	Yes	No	155
Engineering Alumni Admission Bursaries	—	Yes	No	156
Engineering Alumni Admission Scholarship	$500	Yes	No	156
Grabill Admission Scholarship	$500	Yes	No	158
General Foods Scholarships	$500	Yes	No	158
Hagarty Memorial Scholarship	$60	Yes	Yes	159
The Murray Calder Hendry Scholarship	$500	Yes	No	160
Inco Scholarship	$300 + Fees	Yes	No	161
The Leonard Foundation Scholarships	—	Yes	Yes	162
J. Edgar McAllister Foundation	—	Yes	Yes	163
O.H.A. War Memorial Scholarship	$200	Yes	Yes	167
Ontario Chapter American Society for Metals Bursaries (2)	$400	Yes	Yes	150
A.P.E.O. Admission Scholarship	$500	Yes	No	168
Helen E. Rogers Admission Scholarships	—	Yes	Yes	170
Simpson-Sears Limited (Northern Ontario) Scholarship	$100	Yes	Yes	172
Smith and Stone Limited Bursaries	$150	Yes	Yes	172
Walter Sterling Admission Scholarships	—	Yes	No	174
U.T.S. Engineering Scholarship	$250	Yes	Yes	176
Wallberg Admission Scholarships (2)	$500	Yes	No	176
Available to Students Completing the First Year				
Atkinson Incourse Bursaries	—	Yes	No.	151
Baptie Scholarship	—	No	Yes	151

Name	Amount	Application required	Available only to a limited group or single course	See page
Canadian Bechtel Limited Bursaries	—	Yes	No	152
J. P. Bickell Foundation Scholarships	—	No	No	152
T. H. Bickle Prize	$30	No	Yes	153
Crocker Foundation Bursaries	—	Yes	No	154
Dominion-Provincial Student-Aid Bursaries	—	Yes	No	155
*John M. Empey Scholarship	$150	No	No	156
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	161
Inco Scholarship	—	Yes	Yes	161
Johnson's Wax Scholarship	$600	No	Yes	161
Kimberly-Clark Scholarship	$500	No	No	162
John Wolfe McColl Awards	—	Yes	No.	163
Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Physics	$60	No	Yes	164
MacLennan-LacLeod Memorial Prize	$25	No	No	165
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	166
Northern Electric Undergraduate Scholarship	$500	No	Yes	167
Orenda Engines Scholarship	$500	No	Yes	160
Procter and Gamble Bursary	—	Yes	No	168
*Professional Engineers Scholarship	$250	No	Yes	168
*Ransom Scholarship in Chemical Engineering	$150	No	Yes	169
Frederick W. Schumacher Scholarship	—	Yes	Yes	171
S. Ubukata Fund	—	Yes	Yes	175
University Naval Training Division Bursaries	$100	Yes	Yes	176
University of Toronto General Bursaries	—	Yes	No	176
*Wallberg Undergraduate Scholarships (2)	$500	No	No	177
AVAILABLE TO STUDENTS COMPLETING THE SECOND YEAR				
*Harvey Aggett Memorial Scholarship	$75	No	No	149

Name	Amount	Application required	Available only to a limited group or single course	See page
Ardagh Scholarship	$300	No	Yes	150
Automotive Transport Association Bursary	—	Yes	No	151
Babb Bursary Fund	—	Yes	Yes	151
Canadian Bechtel Limited Bursaries	$1200	Yes	No	152
J. P. Bickell Foundation Bursaries	—	Yes	Yes	153
J. P. Bickell Foundation Scholarships	—	No	Yes	152
T. H. Bickle Prize	$30	No	Yes	153
Carveth Metallurgical Ltd. Bursary	$500	Yes	Yes	154
Crocker Foundation Bursaries	—	Yes	No	154
Cyanamid of Canada Scholarship	$750	No	Yes	155
Dominion-Provincial Student-Aid Bursaries	—	Yes	No	155
*John M. Empey Scholarship	$150	No	No	156
J. A. Findlay Scholarship	—	No	Yes	157
Hugh Gall Award	$140	Yes	No	158
Hydro-Electric Power Commission of Ontario Bursary	$500	Yes	No	161
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	161
Johnson's Wax Scholarship	$600	No	Yes	161
The Kennecott Copper Award in Industrial Engineering	$1000	Yes	Yes	162
Kimberly-Clark Scholarship	$500	No	No	162
The Lever Brothers Scholarships	$300	No	Yes	163
Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships	—	No	Yes	164
Charles Gordon Manning Prize	—	No	No	165
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	166
James L. Morris Memorial Prize	$125	No	Yes	166
Northern Electric Undergraduate Scholarship	$500	No	Yes	167
Orenda Engines Scholarship	$500	No	Yes	160
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	173

Name	Amount	Application required	Available only to a limited group or single course	See page
William Storrie Memorial Scholarship	$100	No	Yes	174
*Professional Engineers Scholarship	$250	No	Yes	168
*Rhodes Scholarship	£400	Yes	No	169
Scottish Rite Masons Bursary	$400	Yes	Yes	171
Frederick W. Schumacher Scholarship	—	Yes	Yes	171
Socony-Mobil Oil of Canada Limited Scholarship	$400	No	Yes	173
Edith Tyrrell Memorial Bursary	$500	Yes	Yes	174
University of Toronto Chemical Engineering Club Scholarship	$150	No	Yes	176
University of Toronto General Bursaries	—	Yes	No	176
*Wallberg Undergraduate Scholarships	$500	No	No	177
*William R. Worthington Memorial Scholarship	$400	No	Yes	177
AVAILABLE TO STUDENTS COMPLETING THE THIRD YEAR				
Allied Chemical Canada Limited Scholarship	$850	No	Yes	150
American Institute of Industrial Engineers Scholarship	$150	No	Yes	150
Babb Bursary Fund	—	Yes	Yes	151
F. W. Baldwin Prize	$75	No	Yes	151
Canadian Bechtel Limited Bursaries	—	Yes	No	152
J. P. Bickell Foundation Bursaries	—	Yes	Yes	153
T. H. Bickle Prize	$30	No	Yes	153
*Boiler Inspection and Insurance Company Scholarship	$150	No	Yes	153
*California Standard Company Scholarship	$400	No	Yes	154
Chemical Institute of Canada Prize	$25	No	Yes	154
Crocker Foundation Bursaries	—	Yes	No	154
Dow Chemical of Canada Limited Award	$500	No	Yes	155

Name	Amount	Application required	Available only to a limited group or single course	See page
Dominion-Provincial Student-Aid Bursaries	—	Yes	No	155
*John M. Empey Scholarship	$150	No	No	156
E.I.C. Prize	$50	No	Yes	157
Engineering Society Semi-Centennial Award	$75	No	No	157
J. A. Findlay Scholarship	—	No	Yes	157
James Franceschini Foundation Scholarship	$250	No	Yes	158
Chester B. Hamilton Scholarship	$500	No	Yes	159
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	161
*Jenkins Scholarship in Engineering	$200	No	No	161
Johnson's Wax Scholarship	$600	No	Yes	161
Kennecott Copper Award in Industrial Engineering	$1000	Yes	Yes	162
The Lever Brothers Scholarship	$300	No	Yes	163
Loan Funds	—	Yes	No	177
J. A. D. McCurdy Prize	$75	No	Yes	163
Alexander MacLean Scholarship	$250	No	Yes	165
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	166
Northern Electric Undergraduate Scholarship	$500	No	Yes	167
Orenda Engines Scholarship	$500	No	Yes	160
*Professional Engineers Scholarship	$250	No	Yes	168
RCE Memorial Scholarship	$125	Yes	Yes	170
Murray F. Southcote Scholarship	$100	No	No	173
Frederick W. Schumacher Scholarship	—	Yes	Yes	171
Specification Writers Association Scholarship	$250	No	Yes	173
William Storrie Memorial Scholarship	$100	No	Yes	174
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	173
Edith Tyrrell Memorial Bursary	$500	Yes	Yes	174

Name	Amount	Application required	Available only to a limited group or single course	See page
University of Toronto General Bursaries	—	Yes	No	176
*Wallberg Undergraduate Scholarships	$500	No	No	176
AVAILABLE TO STUDENTS COMPLETING THE FOURTH YEAR				
Henry G. Acres Medal	—	No	Yes	149
American Society of Lubrication Engineers Prize	$75	No	Yes	150
J. P. Bickell Foundation Bursaries	—	Yes	Yes	153
Babb Bursary Fund	—	Yes	Yes	151
Crocker Foundation Bursaries	—	Yes	No	154
Dominion-Provincial Student-Aid Bursaries	—	Yes	No	155
Electrical Manufacturing Co. Limited Prize	$25	No	Yes	156
Hamilton Watch Award	—	No	No	159
Ontario Chapter, A.S.H.R.A.E. Prize	$75	No	No	160
Loan Funds	—	Yes	No	177
Massey-Ferguson Ltd. Scholarships (2)	$500	Yes	Yes	166
Ontario Municipal Electric Association Bursary	$300	Yes	Yes	167
Professional Engineers Gold Medal	—	No	No	169
William Storrie Memorial Scholarship	$200	No	Yes	174
Society of Automotive Engineers Prize	$100	No	No	172
Society of Chemical Industry Merit Award	—	No	Yes	172
"Second Mile Engineer" Award	$200	No	Yes	171
Trane Company of Canada Limited Prize	$200	No	No	174
University of Toronto General Bursaries	—	Yes	No	176
W. S. Wilson Medals	—	No	No	177

Name	Amount	Application required	Available only to a limited group or single course	See page
AVAILABLE TO GRADUATES				
Aluminium Laboratories Limited Fellowship	$2000	Yes	Yes	181
Athlone Fellowships	—	Yes	No	181
J. P. Bickell Foundation Fellowships	$2000	Yes	Yes	181
C.I.L. Fellowships in Chemistry	$4000	Yes	Yes	181
Canadian Lumbermen's Association Timber Research Fellowship	$1250	Yes	No	182
Commonwealth Scholarships	—	Yes	No	182
Consolidated Mining and Smelting Company Graduate Research Fellowships	$3000	Yes	No	182
1851 Exhibition Science Research Scholarships	£275	Yes	Yes	182
Lachlan Gilchrist Fellowship Fund	—	Yes	Yes	183
Thomas H. Hogg Overseas Fellowship	$3000	Yes	Yes	184
Imperial Oil Graduate Research Fellowships	$4000	Yes	Yes	184
International Nickel Graduate Research Fellowships	$3000	Yes	Yes	184
Johnson's Wax Fund Scholarship	—	Yes	Yes	185
McCharles Prize	$1000	No	No	185
The University of Manchester Toronto Fund	£100	Yes	No	185
National Sewer Pipe Limited Scholarship	$500	Yes	Yes	186
Nipissing Mining Research Fellowships	$975	Yes	No	186
H. W. Price Research Fellowship in Electrical Engineering	—	Yes	Yes	186
Raymond Priestley Fellowship	£450	Yes	No	186
Rhodes Scholarship	£400	Yes	No	169
Royal Institution of Great Britain Science Research Scholarships	£350	Yes	No	187
Steel Company of Canada, Ltd., Fellowship	$1500	Yes	Yes	187

Name	Amount	Application required	Available only to a limited group or single course	See page
Spruce Falls Power and Paper Company Fellowships	$1200	Yes	No	187
1940 Toronto Fund.....	£500	Yes	No	188
Wallberg Research Fellowships.	$2500	Yes	No	188
Charles G. Williams Fellowship	$1500	Yes	Yes	188

NOTE—As the value of an endowed scholarship or prize is dependent on the actual income of the fund, it is possible that the value of certain scholarships and prizes at the time of payment may be less than the amount stated in the calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

HENRY G. ACRES MEDAL

The Henry G. Acres Medal is the gift of Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario in the period 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. Entering private practice in 1924, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which was vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

This medal is awarded annually to the student in the Fourth Year who is registered in the course in Civil, Mechanical, or Electrical Engineering, and who obtains the highest aggregate percentage at the annual examinations of the Third and Fourth Years, provided always that the student obtains honour standing in the examinations of the Fourth Year. Receipt of the medal does not preclude a student from being granted such other award as may in the opinion of the Council be appropriate.

HARVEY AGGETT MEMORIAL SCHOLARSHIP

This scholarship was donated by the late Mr. J. T. Aggett, of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual scholarship of the value of the annual income from the fund is to be awarded to a student of the Second Year in this Faculty who, obtaining honours and being one of the first three in his year by his standing at the annual examinations, has been adjudged highest of the three in general student activities and service in the University during his period of attendance. When regulations do not permit the winner to hold this scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a scholarship of higher value.

ALCAN SCHOLARSHIP

The Aluminum Company of Canada, Limited has made available an admission scholarship of a value of $500 to a student entering the First Year of an Honours Course in the Faculty of Arts and Science, the

Faculty of Applied Science and Engineering or in the Faculty of Law. The recipient must attain an academic standing satisfactory to the Committee of Award and demonstrate financial need. It is tenable in the later years provided First Class standing is maintained.

Application should be made to the Registrar of the University by May 1 on the regular Admission Scholarship Application form.

ALLIED CHEMICAL CANADA LIMITED SCHOLARSHIP

Allied Chemical Canada Limited has presented a scholarship of the value of tuition fees plus $250 to the student and a grant of $250 to the University, to be awarded to a student registered in the Fourth Year of the course in Chemical Engineering who has attained honour standing in the examinations of the Third Year. The recipient must be a Canadian or an American citizen and must not already be receiving other awards exceeding $250.

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS SCHOLARSHIP

The Southern Ontario Chapter, American Institute of Industrial Engineers offers a scholarship of $150 to a student entering the Fourth Year of the Industrial Engineering course who has consistently maintained a high academic standing, but not necessarily honour standing, during the previous three years.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS PRIZE

The Toronto Section of the American Society of Lubrication Engineers offers an annual prize of $75 to a student in the Fourth Year in Mechanical Engineering whose Thesis dealing with Lubrication is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory. The Prize is accompanied by a donation of $25 to the Department to purchase books on Lubrication.

ONTARIO CHAPTER, AMERICAN SOCIETY FOR METALS BURSARY

The Ontario Chapter, American Society for Metals provides two bursaries of a value of $400 each for students entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made for the Session 1958–59.

ARDAGH SCHOLARSHIP

The Ardagh Scholarship, of the annual value of the income from $6,500, has been provided in memory of his parents by Professor E. G. R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry in the

Faculty. It is awarded to the student who attain the highest standing in Honours at the annual examinations of the Second Year in the Course in Chemistry Engineering. The first award was made on the results of the annual examination of 1946.

ATKINSON IN-COURSE BURSARIES

Atkinson In-Course Bursaries, gift of the Atkinson Charitable Foundation, are awarded annually to students in the second or higher years of their courses. Applicants must have at least Second Class honours in the final examinations of the preceding year, demonstrate financial need and be a resident of the Province of Ontario.

Applications must be submitted to the Registrar of the University on or before December 1.

ATA TRUCKING INDUSTRY EDUCATIONAL FOUNDATION BURSARIES

The Automotive Transport Association of Ontario has established a bursary fund for students in the second or higher years of any undergraduate degree course who find themselves in serious financial need due to sudden, unexpected personal or family difficulties. Applications may be submitted to the University Registrar at any time during the session and the number and value of the bursaries will vary at the discretion of the Committee of Award.

THE BABB BURSARY FUND

Bursaries from this fund are available to students in any year of the Aeronautics Option in Engineering Science. Application is made through the Secretary of the Faculty.

THE F. W. BALDWIN PRIZE

The F. W. Baldwin Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44), in memory of Frederick Walker "Casey" Baldwin, a graduate of the School of Practical Science, who made a significant contribution in the field of Aeronautics in Canada; and who flew, on March 12, 1908, near Hammondsport, N.Y., the "Redwing," the first biplane built by the Aerial Experiment Association.

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in the annual examinations of Third Year in "structural subjects."

The first award was made on the results of the examinations of the Session 1953–54.

BAPTIE SCHOLARSHIP

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie, of Ottawa, and the Board of Governors has directed that a scholarship of one half the annual income shall be awarded annually to an engineering student on the record of

the first Year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to $75.

The conditions of the award are as follows: That the scholarship be awarded to the student who, in the annual examinations of the First Year, enrolled in any one of the courses of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, or Metallurgy and Materials Science, obtains the highest aggregate percentage of marks in those subjects which are common to the First Year curricula of those courses. The first award was made on the results of the annual examinations of the Session 1925–26.

CANADIAN BECHTEL LIMITED BURSARIES

Canadian Bechtel Limited has established Bursaries in the Faculty of Applied Science and Engineering of an annual value of $1,200 to provide not more than four awards, each of a minimum value of $200 and a maximum value of $600. Two awards will be made to First Year students and one or two awards to students registered in any year of the Faculty. Applicants must demonstrate financial need and have academic standing satisfactory to the Faculty Council.

Application must be made to the Secretary of the Faculty on or before October 1.

J. P. BICKELL FOUNDATION SCHOLARSHIP

The Trustees of the J. P. Bickell Foundation have established scholarships, the number to be determined annually, in the Faculty of Applied Science and Engineering of a possible value of $1,500 payable $500 in the First Year and provided honours are obtained at the Annual Examinations, $500 in the Second and Third Years.

An applicant must obtain an average of at least 75% at the Ontario Grade XIII examinations immediately preceding his admission to the university and must undertake to enrol in Chemical Engineering, Metallurgy and Materials Science or Geological Engineering. Failing suitable candidates in the courses mentioned students registered in the Second Year Honour course in Geological Sciences, or Physics and Geology in the Faculty of Arts and Science who are academically qualified are eligible. These awards are of the same value and are tenable in the Second, Third and Fourth Years of the course, subject to maintenance of the required academic standing. If any scholarships are not awarded to those mentioned above, students registered in the Third Year of the Engineering Science course in the Faculty of Applied Science and Engineering and taking the Physical Metallurgy or the Geophysics option who are academically qualified are eligible. In this case the scholarship will have a value of $1,000, payable $500 in each of the Third and Fourth years, provided the required academic standing is maintained.

Applications from those entering First Year must be submitted to the Registrar of the University not later than May 1 on the regular admission scholarship application form. In other cases, applications are not required.

J. P. BICKELL FOUNDATION BURSARIES

The Trustees of the J. P. Bickell Foundation have established the J. P. Bickell Foundation Bursaries in the Faculty of Arts and the Faculty of Applied Science and Engineering. An applicant must be enrolled in Honour Science or in Mathematics, Physics and Chemistry in the Faculty of Arts, in which case he must undertake to study mining or geology in his higher years; or be enrolled in a higher year of an honour course in the geological or geophysical field in the Faculty of Arts; or be enrolled in Chemical Engineering, Mining Engineering, Metallurgy and Materials Science, or Geological Engineering in any year of the Faculty of Applied Science and Engineering. He must demonstrate financial need and have satisfactory academic standing.

Application must be made to the Registrar of the University on or before December 1.

THE T. H. BICKLE PRIZE

The T. H. Bickle Prize is the gift of Mr. and Mrs. E. W. Bickle in memory of their son, T. H. Bickle, an undergraduate of Trinity College and a member of the Senior Intercollegiate Swimming Team at the time of his death in 1937. The income from the endowment fund will be used to purchase a suitable prize to be awarded annually to a member of the Senior Intercollegiate Swimming Team of this University in any year, faculty or school. The Committee of Award shall consist of the Dean of the Faculty of Arts, the University Registrar, the Director of Athletics, and the Honorary Coach of Swimming. In awarding the Prize the Committee shall consider the character, scholarship, and general interests of the members of the team.

J. W. BILLES ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of J. W. Billes, open to students entering any degree course in the University. The value in each year is a minimum of $200 and a maximum of $1,500 dependent upon the financial need of the recipient. Applicants must satisfy the normal admission scholarship standards in their Grade XIII examinations to be eligible for an award and maintain first class honour standing to enjoy the scholarship in higher years. The number of scholarships awarded in any one year may be varied dependent upon the available funds.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

BOILER INSPECTION AND INSURANCE COMPANY SCHOLARSHIP

The Boiler Inspection and Insurance Company of Canada offers a scholarship in the Course in Mechanical Engineering of the value of $150 to the student who obtains highest honour standing in the regular examinations of the Third Year.

The successful candidate will be expected to proceed to his Fourth Year during the session next following the date of the award.

The amount of the award will be credited by the Chief Accountant to the fees of the Fourth Year of the successful candidate.

CALIFORNIA STANDARD COMPANY SCHOLARSHIP

The California Standard Company has presented a scholarship of $400 to a student who achieves outstanding results in the annual examinations of the Third Year in the Geophysics Option in Engineering Science or in Geological Engineering in the Faculty of Applied Science and Engineering or achieves the highest standing at the annual examinations of the Third Year in Physics and Geology or Geological Sciences in the Faculty of Arts and Science.

The awards alternate annually between the Faculties of Applied Science and Engineering and Arts and Science and the First Award was made in the session 1960–61 in the Faculty of Applied Science and Engineering.

CARVETH METALLURGICAL LTD. BURSARY

Carveth Metallurgical Ltd. provides one or more bursaries to a total value of $500 for students entering the Third Year of Metallurgy and Materials Science. The award is made primarily on the basis of Second Year standing, but the need for financial assistance will also be taken into consideration.

The Bursary is available every third year, beginning in the Session 1961–62, and is to be awarded on the recommendation of the Department of Metallurgy and Materials Science. Applications should be made by letter to the Secretary of the Faculty of Applied Science not later than September 1 of the year in which the award is tenable.

CHEMICAL INSTITUTE OF CANADA PRIZE

The Chemical Institute of Canada offers a prize of the annual value of $25 in books to the student registered in the course in Chemical Engineering who, having obtained honours, receives the highest standing in the written and laboratory work of the Third Year.

The first award was made on the results of the final examinations of 1947.

CROCKER FOUNDATION BURSARIES

The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

CYANAMID OF CANADA SCHOLARSHIP

As a part of their programme to encourage technical development in Canada, Cyanamid of Canada Limited offers a scholarship of the value of $750 to a student entering the Third Year in Chemical Engineering. The award is made to a student who has demonstrated high academic ability and outstanding scholarship in the work of the Second Year.

The first award at the University of Toronto was made in 1964.

DOMINION MAGNESIUM LIMITED BURSARY

Dominion Magnesium Limited provides a bursary of $400 for a student entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made in the Session 1958–59.

DOMINION-PROVINCIAL STUDENT-AID BURSARIES TYPE "A"

These Bursaries are available to students in financial need who are resident in Ontario, are entering the First Year of University, and have attained an average of at least 66% on eight Grade XIII papers. Application is made not later than June 10, through the Principles of the secondary school which the student is attending.

DOMINION-PROVINCIAL STUDENT-AID BURSARIES TYPE "B"

Under this programme, Bursaries may be awarded to students in financial need who are resident in Ontario and who are in attendance at the University of Toronto. To be eligible, students must have obtained not less than 66% at their last annual examination. Further information may be obtained from the Secretary of the Faculty, to whom application must be made by the first week in October.

DOW CHEMICAL OF CANADA LIMITED AWARD

Dow Chemical of Canada Limited have provided funds for an annual award of $500 to a student in Chemical Engineering in the Faculty of Applied Science and Engineering, and a grant-in-aid of $250 to be used in the winner's department to help defray the cost of equipment, supplies and administration.

The winner must:

(*a*) be registered in the Third Year in Chemical Engineering (the award will be made in the second term of the Third Year and will be paid to the winner during his Fourth Year);

(*b*) be in the upper half of the class;

(*c*) have demonstrated leadership in extra-curricular activities.

The award is not tenable with other awards in the gift of the Senate. Application is not required.

THE ELECTRICAL MANUFACTURING COMPANY LIMITED PRIZE

The Electrical Manufacturing Company Limited has established an annual Prize of $25 in the Faculty of Applied Science and Engineering.

The winner must:

(*a*) be registered in the Fourth Year in Electrical Engineering;

(*b*) obtain the highest aggregate percentage of marks at the final examinations in the subjects of the Fourth Year related to electrical distribution equipment, the subject to be determined by the Head of the Department of Electrical Engineering.

This Prize is tenable with other awards in the gift of the Senate.

THE JOHN M. EMPEY SCHOLARSHIPS

The John M. Empey Scholarship Fund was established under a bequest of $10,000 in the Will of the late John Morgan Empey, B.A.Sc., 1903. Three scholarships of equal value are provided from the income from the Fund. One of these scholarships is awarded in each of the First, Second, and Third Years on the results of the annual examinations, to a student who, taking honours, obtains the highest average percentage of marks in the written and laboratory subjects of his Year. The scholarships are open to any students registered in the Faculty. In case the winner of any one of these scholarships does not attend this Faculty during the session next following the award, the right to the scholarship shall be forfeited and the award shall be made to another eligible student. The scholarships were awarded for the first time in 1944.

ENGINEERING ALUMNI ADMISSION BURSARIES

The Engineering Alumni Association has made a number of bursaries with a maximum value of $600 each available annually. Applicants must be residents of Ontario, register in the First Year of the Faculty of Applied Science and Engineering, and need financial assistance.

Applicants should consult their secondary school Principal for details. Further information may be obtained from the Chairman, Engineering Alumni Education Committee, Faculty of Applied Science and Engineering, University of Toronto.

ENGINEERING ALUMNI ADMISSION SCHOLARSHIP

The Engineering Alumni Admission Scholarship, the gift of the Engineering Alumni Association, of the value of $500, is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty

and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

ENGINEERING INSTITUTE OF CANADA PRIZE

The Engineering Institute of Canada, having in view that one of its objects is to facilitate the acquirement and interchange of professional knowledge among its members, offers an annual prize of Fifty Dollars in this University, commencing 1931, to the student who, in his Third Year in any one of the six courses of Engineering, has proved himself most deserving as disclosed by the examination results of the year, in combination with his activities in the Engineering Society or with a local branch of another recognized engineering organization.

ENGINEERING SOCIETY SEMI-CENTENNIAL AWARD

The Engineering Society Semi-Centennial Award, to the value of $75 was established in 1931 to commemorate the semi-centennial of the founding of the "School". The award is made to a student entering the final year.

The selection is based upon the following qualifications, which bear equal weight in the selection of the winner: (*a*) General "School" activities. (*b*) Contributions to the Engineering Society Executive Committee. (*c*) Personality, and social and athletic activities. (*d*) Academic standing.

J. A. FINDLAY SCHOLARSHIPS

These scholarships were established through a legacy bequeathed by the late Miss Janet Findlay to the Department of Mechanical Engineering. Two scholarships are available, each of a value of one half of the income of the fund, to students in this Course, one for a student in the Third Year, the other for a student in the Fourth Year, but only if the student continues his course in Mechanical Engineering. The selection will be made, on recommendation of the Head of the Department of Mechanical Engineering, from amongst the four students having the highest average percentage of marks at the annual examinations in the Second and Third Years respectively, but in making the award the student's general character, fitness for his profession, and financial circumstances will be given consideration. In case a student who has been awarded one of the scholarships changes his course or does not attend this University during the next following session, he shall forfeit his right to the scholarship and the award shall be made to another eligible student.

THE JAMES FRANCESCHINI FOUNDATION SCHOLARSHIP

This scholarship, of a value of $250, is awarded to the student in Civil Engineering who achieves the highest standing, with honours, at the annual examinations of the Third Year among those who do not hold an award of a value of $100 or more based on the results of these examinations.

HUGH GALL AWARD

The Hugh Gall Award, of the annual value of One Hundred and Forty Dollars, the gift of the Graduate Class of 1910, "to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career", was established in 1946 for a five year period and, through the generosity of Mrs. Hugh Gall extended for a further three year period. It is awarded to a student, who, having completed his First Year with a general average of at least 66% without conditions, has entered the Second Year, and is in special need of financial assistance in order to enable him to continue his course. It is desirable, but not necessary, that the recipient shall not already have been given any other scholastic award or scholarship applicable to the second year and he shall have shown indications of his firm intention and ability to follow successfully the profession of engineering.

Any second year student in the Faculty of Applied Science and Engineering is eligible to apply for this Bursary. Applications should be made to the Secretary of the Faculty not later than one month after the opening of the session.

GENERAL FOODS SCHOLARSHIP

This scholarship is awarded for general proficiency in the final secondary school year to a student entering the Faculty of Arts and Science, Applied Science and Engineering or Food Science, and is open for competition by any student resident in Canada. The value is $500 for each of four years, providing first class standing in maintained.

Ontario residents apply on the regular admission scholarship application form.

Students resident outside Ontario may obtain application forms from the Awards Department, Office of the Registrar, University of Toronto.

THE GRABILL ADMISSION SCHOLARSHIP

The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $400. It is awarded to the candidate who has standing amongst those with the highest average percentages in the subjects of Ontario Grade XIII required for admission to the Faculty of Applied Science and Engineering. Applicants are required to write the Problems paper but standing in this paper is used only as auxiliary information.

The candidate must write the Grade XIII examinations at one sitting in the June preceding entry to the University after not more than one year's instruction in Grade XIII and must register in the Faculty of Applied Science and Engineering.

Application should be made to the Registrar of the University on the regular Admission Scholarship form by May 1.

THE REGINALD AND GALER HAGARTY SCHOLARSHIP

The Reginald and Galer Hagarty Scholarship, in memory of the dearly beloved sons of Lieutenant-Colonel E. W. Hagarty, B.A. 1883, M.A. 1908, and Charlotte Ellen Hagarty, his wife. Reginald Edward Walter Hagarty, B.A.Sc. (Honours) 1908, a graduate of the University in the Faculty of Applied Science and Engineering and at the time of his death on April 29, 1925, a Consulting Structural Engineer. Lieutenant Daniel Galer Hagarty, Princess Patricia's Canadian Light Infantry, a member of the class of 1916 in Applied Science, enlisted for the Great War at the end of his third year in June, 1915, killed in action in Sanctuary Wood, June 2, 1916. The scholarship is given in recognition of the fact that their father was an honour graduate in Classics of the University of Toronto. It is of the value of the annual interest on the capital sum of $2,000 and is to be awarded to a student who has been enrolled for his Grade XIII Year at Harbord Collegiate Institute and having obtained at least the required standing in each of the Grade XIII subjects necessary for admission to the Faculty, obtains the highest standing in English, a language other than English, and Mathematics, among the students who apply for the award from the Collegiate. He will be required to: (*a*) register in the Faculty of Applied Science and Engineering, (*b*) sign a declaration to the effect that he is willing to take up arms in the defence of Canada and the British Commonwealth should necessity arise as declared by the Parliament of Canada. The Scholarship was offered for award for the first time in 1945. Application should be made to the Registrar of the University on the regular admission scholarship application form not later than May 1.

CHESTER B. HAMILTON SCHOLARSHIP

Members of the family of the late Chester B. Hamilton, a graduate of this Faculty in 1906, have presented a Scholarship in his memory of the annual value of $500. It is held by a Fourth Year student in Mechanical Engineering who has achieved outstanding academic standing at the Annual Examinations of the Third Year.

The first award was made on the results of the examinations for the Session 1958–59.

HAMILTON WATCH AWARD

Hamilton Watch Company, Lancaster, Pa. presents a wrist watch, suitably engraved, to the Fourth Year student in the Faculty of Applied

Science and Engineering who at the annual examinations attains Honour standing and who has achieved high aggregate marks during his four years in the social-humanistic subjects common to all courses.

ONTARIO CHAPTER, A.S.H.R.A.E. PRIZE

The Ontario Chapter of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers offers an annual prize of $75, first awarded in 1931, for a period of five years, and extended indefinitely in 1935. The prize will be awarded to a student in either the Third or Fourth Year in any Course of the Faculty who, in the opinion of the Department of Mechanical Engineering, has written the most satisfactory thesis on a subject dealing with heating, ventilating, air-conditioning or refrigeration, such thesis being prepared under special arrangements made by the Department of Mechanical Engineering, the result to be reported to the Council with the annual examination results. The thesis must be handed in not later than February 15. The prize will not necessarily be awarded in any year.

Application should be made to the Department of Mechanical Engineering.

HAWKER SIDDELEY CANADA LIMITED (ORENDA ENGINES DIVISION) SCHOLARSHIPS

Hawker Siddeley Canada Limited (Orenda Engines Division) have donated three scholarships each of a value of $500, awarded annually to students completing the First, Second and Third Years respectively in courses other than Geological Engineering. These scholarships are awarded to students with high academic standing and in cases of close competition, preference will be given to the student who indicates that he possesses initiative and leadership qualities and that he will be a credit to his profession after graduation.

This award may be held with other awards provided that the monetary value of the other awards does not exceed $100. The first award was made in the Session 1955–56.

THE MURRAY CALDER HENDRY SCHOLARSHIP

This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of the income from a capital sum of $10,000 and the recipient must:

(*a*) have attained an average of at least 75% on nine grade XIII examination papers, written at one sitting, required for admission to the Faculty and have the highest marks in the Problems paper;

(*b*) be entering the First Year of any course in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University by May 1 on the regular University Admission Scholarship Application form.

The first award was made in the Session 1962–63.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO BURSARY

The Hydro-Electric Power Commission of Ontario has provided a bursary of the value of $500, which may be awarded to a student entering the second year of the courses in Mathematics and Physics or Commerce and Finance in the Faculty of Arts and Science, or any course in the Faculty of Applied Science and Engineering. Application should be made on the regular in-course bursary form not later than December 1.

IBM—THOMAS J. WATSON MEMORIAL BURSARY FUND

International Business Machines Company Limited has made available one or more bursaries of a total annual value of $1,000 to students registered in any year of a full time course in the university who have standing satisfactory to the Committee of Award and demonstrate financial need.

Application should be made to the Registrar of the University by October 31.

THE INCO SCHOLARSHIP

The International Nickel Co. of Canada Limited has established a Scholarship for students entering the University. Each Scholarship provides for tuition fees plus $300 and may be continued throughout a four-year course if satisfactory standing is maintained.

To be eligible for consideration the applicant must obtain an average of 75% or over in the Ontario Grade XIII subjects required for admission to his course and demonstrate financial need.

Application must be made to the Registrar of the University by May 1 on the regular scholarship application form.

JENKINS SCHOLARSHIP

The Jenkins Scholarship, presented by Jenkins Bros., Limited, Montreal, first awarded in 1925, has been donated to continue indefinitely.

This Annual Scholarship, of the value of $200, is awarded to the student of the Third Year registered in any course of the Faculty who has the highest aggregate of percentages for the First, Second, and Third Years.

JOHNSON'S WAX SCHOLARSHIP

S. C. Johnson and Son Limited, Brantford, Ontario, have established a Scholarship of an annual value of $600 in each of the Second, Third and Fourth Years or a total possible value of $1,800.

The recipient must:

(*a*) be registered in Chemical Engineering in the years in which the Scholarship is awarded and held;

(*b*) in the opinion of the Council be the most promising and deserving

member of the class, obtaining Honours in the final examinations of the First Year;

(*c*) in his Second and Third Years, maintain academic standing satisfactory to the Council, not necessarily Honours, for the continued enjoyment of the Scholarship.

In its discretion the Council may recommend the award of any portion of the Scholarship, lost by the original recipient by failure to maintain satisfactory academic standing, to another student of the year(s) in which the Scholarship would otherwise have been enjoyed.

The first award was made on the results of the annual examinations written in April 1954. It is not tenable with any other Scholarship.

KENNECOTT COPPER AWARD IN INDUSTRIAL ENGINEERING

Kennecot Copper Corporation offers an Annual Award in Industrial Engineering of the value of $1,000. The recipient of the Award must:

(*a*) be registered in the Second, Third or Fourth year of the course in Industrial Engineering;

(*b*) have attained Honours in the final examinations of the previous year;

(*c*) show qualities of leadership and initiative.

The financial need of the student may be taken into consideration.

Application should be made to the Secretary of the Faculty by October 30.

KIMBERLY-CLARK CORPORATION OF CANADA LIMITED SCHOLARSHIPS

Kimberly-Clark Corporation of Canada Limited has presented two scholarships of a value of $500 each and each scholarship is acompanied by a grant of $100 to the general funds of the University. One scholarship is awarded to an outstanding student of the First Year and one to an outstanding student of the Second Year as indicated by the examination results of their respective years. Students in all courses of the First and Second Years are eligible.

The First awards were made on the results of the annual examinations for 1957–58.

THE LEONARD FOUNDATION SCHOLARSHIPS

Leonard Foundation Scholarships are awarded each year to selected students in Universities and Colleges across Canada, including the University of Toronto. The Trust Deed states: "Preference in the selection of students for scholarships shall be given to the sons and daughters respectively of the following: (*a*) clergymen, (*b*) school teachers, (*c*) officers, non-commissioned officers and men, whether active or retired, who have served in Her Majesty's military, naval or air forces, (*d*) graduates of the Royal Military College of Canada, (*e*) members of the Engineering Institute of Canada, (*f*) members of the Mining and Metallurgical Institute of Canada."

All applicants must be nominated by a member of the General Committee. The latest date for the receiving of applications is March 31, for the following academic year. Further information regarding the procedure to be followed in applying for these scholarships may be obtained by writing to Dr. W. E. Taylor, Honorary Secretary, The Leonard Foundation, c/o Toronto General Trusts Corporation, 253 Bay Street, Toronto.

THE LEVER BROTHERS SCHOLARSHIPS

Lever Brothers Limited have established two Scholarships of $300 each in the Department of Chemical Engineering. The Scholarships will be awarded to a student of the Second Year and to a student of the Third Year in Chemical Engineering to be held in the Third and Fourth Years respectively. The award is based on outstanding scholarship at the annual examinations.

The first awards were based on the annual examinations of 1957.

THE J. EDGAR MC ALLISTER FOUNDATION

Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1891, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mining, Mechanical, Chemical, Electrical and Metallurgy and Materials Science. Inquiries should be made in the Faculty Office.

THE JOHN WOLFE MC COLL MEMORIAL AWARDS

These six awards, two of which are open to students in the Faculty of Applied Science and Engineering, are the gift of the estate of the late John Wolfe McColl. The awards have a minimum value of $250 and a maximum of $750. Applicants must have obtained First Class Honours at the final examinations of the preceding year, whether Ontario Grade XIII or at the University of Toronto, demonstrate financial need and be enrolled or undertake to enrol in either Engineering Science or Chemical Engineering. Students seeking first admission to the University must submit applications for an award to the Registrar of the University on or before May 1. Students in the University must submit applications for an award to the Registrar of the University on or before October 15.

THE J. A. D. MC CURDY PRIZE

The J. A. D. McCurdy Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44) in honour of John Alexander Douglas McCurdy, a graduate of the School of Practical Science, who "made the first flight in Canada on February 23, 1909, with a heavier-than-air machine."

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in annual examinations of the Third Year in the subjects related to Aerodynamics.

The first award was made on the results of the examinations of the Session 1953–54.

THE GARNET W. MC KEE-LACHLAN GILCHRIST SCHOLARSHIP IN ENGINEERING SCIENCE

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a Scholarship in the First Year of the Course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual examinations of the First Year in the Course in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in honours in the Course. In order to receive payment the winner must register in the Second Year of the Course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations of 1947.

THE GARNET W. MC KEE-LACHLAN GILCHRIST GEOPHYSICS SCHOLARSHIPS

Financial assistance was received by Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, from certain organizations and individuals to help him in the prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. To this fund have been added additional amounts received from the estate of the late Garnet W. McKee and from the Hollinger Consolidated Gold Mines Ltd. They are awarded by the Senate, on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the Annual Examinations of 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of the income from $4,000 is awarded to the student in the Second Year in the Course of Engineering Science who obtains the highest aggregate standing at the examinations of the First and Second Years in the Course, provided always that the student obtains honour standing at the examinations of the Second Year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of the income from $3,000 is awarded to the student in the Second Year in the Course of Engineering Science who, of those students who elect to proceed in the Third Year in the Geophysics Option of the Course, obtains the highest aggregate standing at the examinations of the First and Second Years, pro-

vided always that the student obtains honour standing at the examinations of the Second Year, and excluding always the student to whom the First Lachlan Gilchrist Geophysics Scholarship has been awarded.

If in any year there is no student who has fulfilled the conditions as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second Year in the Course in Engineering Science who obtains the second highest aggregate standing at the examinations of the First and Second Years of that Course, provided always that such student obtains honour standing in the examinations of the Second Year.

THE ALEXANDER MAC LEAN SCHOLARSHIP

This scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A. (1908) who retired in 1954. The scholarship, of the value of $250, is awarded to a student in the Third Year of Geological Sciences, Faculty of Arts, or in the Third Year of Geological Engineering, Faculty of Applied Science and Engineering, who, obtaining not less than 75% in the work of the year, obtains the highest standing in the geological subjects common to the two courses.

The first award was made in 1955.

MAC LENNAN-MAC LEOD MEMORIAL PRIZE

The Graduating Class of 1910 has donated an annual prize, known as "The MacLennan-MacLeod Memorial Prize", in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug. MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of $25, is awarded to the First Year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual written examinations; or, in the event of more than one student obtaining equally high rank in Calculus, the award is made to the one of these who also has the highest standing in some other subject common to the competitors, such as Analytical Geometry, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in a subsequent year.

CHARLES GORDON MANNING PRIZE

The Charles Gordon Manning Prize was established by a bequest under the Will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the Prize.

The recipient must be enrolled in the Second Year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations specified for the award of that Scholarship, namely, obtaining honours in his final examinations and being one of the first three in his year by his standing at those examinations relative to the pass requirements in his Department and being "adjudged highest of the three in general student activities and service in the University during his period of attendance."

The first award was made on the results of the Annual Examinations of 1954.

MARSLAND ENGINEERING LIMITED SCHOLARSHIP

The Marsland Engineering Limited Scholarship, the gift of Marsland Engineering Limited, has a value of $250. It is awarded to the student who, having been granted a Dominion-Provincial Student Aid Bursary in his First Year, is registered in Mechanical or Electrical Engineering and obtains the highest average percentage of marks, with honours, at the annual examination of the First, Second or Third Years in the session in which the award is made.

The first award was made at the annual examinations of 1954.

MASSEY-FERGUSON LIMITED SCHOLARSHIPS

Massey-Ferguson Limited has established two scholarships each of an annual value of $250, to be awarded on the recommendation of the Council of the Faculty of Applied Science and Engineering to students registered in the Fourth Year of the Courses in Mechanical Engineering or Industrial Engineering. In making the award academic achievement, financial need, extra-curricular activities and such other factors as may be deemed appropriate will be taken into consideration.

Application should be made to the Secretary of the Faculty not later than October 15.

JAMES L. MORRIS MEMORIAL PRIZE

The James L. Morris Memorial Prize is the gift of Mrs. J. H. Craig and Mr. J. R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career. Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For 43 years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal, power and bridge work.

This Prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second Year in the Course in Civil Engineering who obtains the highest aggregate percentage at the annual

examinations of the First and Second Years of the course, provided always that the student obtains honour standing at the Examinations of the Second Year.

NORTHERN ELECTRIC UNDERGRADUATE SCHOLARSHIP

The Northern Electric Company Limited have established a Scholarship in the Faculty of Applied Science and Engineering and the Faculty of Arts of an annual value of $500. In this Faculty the scholar must be registered in the First, Second or Third Year of Electrical Engineering, Mechanical Engineering, Engineering Science or Industrial Engineering. He must also (*a*) be a Canadian citizen or landed immigrant and (*b*) have a minimum of 75% or its equivalent in the previous annual examinations, in this or another recognized University. This scholarship is not tenable with other awards from commercial sources, or with awards stipulating subsequent employment as a condition (e.g. R.O.T.P.).

The award is made alternately in the two faculties, the first in the Faculty of Arts in 1959 and in the Faculty of Applied Science and Engineering in 1960 and in a similar manner thereafter. Application is not required.

THE ONTARIO HOCKEY ASSOCIATION WAR MEMORIAL SCHOLARSHIP

The Ontario Hockey Association War Memorial Scholarship, the gift of the Ontario Hockey Association, is to be awarded annually at the Grade XIII examination to an applicant whose father served overseas with the Canadian Forces in World War I.

The value of this scholarship is $100 in cash, with an allowance of the same amount on the tuition fee for each session.

In determining the award of the scholarship, the academic qualifications of the candidate shall be first taken into account, provided always that no candidate shall be eligible for an award who has not met all the conditions required by the University of candidates for admission scholarships generally; but, *cæteris paribus*, the award shall be made to a student who is in proved need of assistance.

The award shall be made by the Senate of the University upon the report of a committee to be appointed by the Senate, upon which committee there shall be always one member of the Staff of the University who shall be deemed to be the representative of the Association.

Application should be made to the Registrar of the University on the regular scholarship application form not later than May 1.

ONTARIO MUNICIPAL ELECTRIC ASSOCIATION BURSARY

District No. 4 of the Ontario Municipal Electric Association has provided a Bursary of $300 in the Faculty of Applied Science and Engineering.

An applicant for the Bursary must:

(*a*) be registered in the Fourth Year, Electrical Engineering;

(*b*) have good academic standing;

(*c*) be in need of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

PROCTER AND GAMBLE BURSARY PLAN

Procter and Gamble Bursaries, the gift of the Procter and Gamble Company of Canada, are awarded annually to students in all years. Applicants must have at least Second Class Honours or better in the final examinations of the preceding year and demonstrate financial need. Applications must be submitted to the Registrar of the University on or before December 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO ADMISSION SCHOLARSHIP

The Association of Professional Engineers of the Province of Ontario has established an Admission Scholarship in Engineering of the value of $500. It is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Application must be made to the Registrar before May 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO SCHOLARSHIPS

The Association of Professional Engineers of the Province of Ontario offers Scholarships of a value of $250 in each of the First, Second and Third Years in the Faculty of Applied Science and Engineering in any course, to the students who, taking Honours, obtain the highest standing in the work of their respective years.

These scholarships will not be awarded to students who hold other scholarships.

PROFESSIONAL ENGINEERS GOLD MEDAL

The Association of Professional Engineers of the Province of Ontario has established in the Faculty of Applied Science and Engineering an award in the form of a gold medal accompanied by a gift of technical books of an approximate value of $50. The award will be made to the student of the final undergraduate year in any course who, taking honours, obtains the highest weighted average percentage in the practical work and written examinations of the year.

RANSOM SCHOLARSHIP IN CHEMICAL ENGINEERING

The Ransom Scholarship in Chemical Engineering is presented by A. C. Ransom, Esq., of Toronto, for the purpose of encouraging and giving financial assistance to students who choose the field of Chemical Engineering. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount such as will be derived from the income of this sum. The first award was made on the results of the annual examinations of 1938.

The scholarship will be awarded annually to the student registered in the Course in Chemical Engineering who obtains the highest aggregate percentage of marks in the examinations of the First Year. The scholarship will be paid to the winner only if he proceeds to take his Second Year in the Course in Chemical Engineering in the University of Toronto.

THE RHODES SCHOLARSHIP

The Rhodes Trustees offer for award in the Province of Ontario two out of ten of the Rhodes Scholarships for Canadians, each of the value of £900 and tenable at Oxford University for a period of two years; in certain cases, a third year may be authorized.

Each candidate must be a British subject with at least five years domicile in Canada and unmarried; he must have passed his nineteenth but not his twenty-fifth birthday on October 1 of the year *for* which he is elected; he must have completed the first year and have entered upon the second year of his course at a Canadian university at the time of application.

A candidate may apply either for the province in which he has his private home or residence, or for the province in which he has taken his university course.

In that section of the will in which he defined the general type of scholar he desired, Mr. Rhodes mentioned four groups of qualities, the first two of which he considered most important.

(1) Literary and scholastic attainments;
(2) Qualities of manhood, truth, courage, devotion to duty, sympathy, kindliness, unselfishness, and fellowship;
(3) Exhibition of moral force of character and of instincts to lead and to take an interest in his fellows;

(4) Physical vigour, as shown by fondness for and success in outdoor sports.

Some definite quality of distinction, whether in intellect, character or personality, or in any combination of these, is the most important requirement. Financial need does not receive special consideration.

Forms of application and full information regarding these scholarships may be obtained from the Registrar, University of Toronto, or from the secretary of the Ontario Selection Committee, Alistair W. Gillespie, Esq., Suite 1602, 50 King St. W., Toronto. Selection is made in December for the following year and all applications must reach the provincial secretary before November 15 annually.

R.C.E. MEMORIAL SCHOLARSHIP

The Memorial Fund Committee of the Royal Canadian Engineers has established the R.C.E. Memorial Scholarship of a value of $125, open to students who have successfully completed their second to last year in the Faculty of Applied Science and Engineering or the School of Architecture.

A candidate must be

(*a*) a member in good standing of the Canadian Officers Training Corps and have successfully completed one summer season's training

or

(*b*) an ex-member of the Canadian Officers Training Corps who has successfully completed two years of C.O.T.C. Training and has transferred to the Canadian Army (Militia) or to the Canadian Army (Supplemental Reserve)

or

(*c*) a member of the Canadian Army (Regular) attending University under the Regular Officers Training Plan.

Selection is made on the basis of academic standing and of qualities of leadership.

Application forms may be obtained from the office of the Registrar.

HELEN E. ROGERS ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of Helen E. Rogers open to students entering any degree course in the University. Preference is given to applicants from outside Ontario but failing such candidates awards may be made to qualified Ontario students. Recipients must have a standing satisfactory to the Committee of Award on first admission and may continue to enjoy the scholarship in the upper years provided they maintain first class standing. The value in each year is a minimum of $200 and a maximum of $1,500 dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

FREDERICK W. SCHUMACHER SCHOLARSHIP

The Frederick W. Schumacher Scholarship has been established in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must (*a*) be enrolled in the Second, Third or Fourth years in Mining Engineering or Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and (*b*) must have high academic standing.

Applications must be submitted to the University Registrar not later than October 15.

THE SCOTTISH RITE MASONS' BURSARY

The Scottish Rite Masons' Bursary, the gift of the Scottish Rite Masons of Toronto, of the value of $400 is awarded to a student enrolled in the Second Year who is a member of the Masonic Order, or a son, brother, nephew, daughter, sister or niece of a member of the Masonic Order. Consideration will be given to financial need and academic standing. Evidence of connection with the Masonic Order and information regarding financial need must be given with the application which must be submitted to the Secretary of the Faculty on or before October 15.

"SECOND MILE ENGINEER" AWARD

The Class of 3T5, convinced that a successful engineer must not only be professionally competent but also constantly aware of his responsibilities to humanity, and inspired by an address of President William E. Wickenden of the Case School of Applied Science, Cleveland, called "The Second Mile", which was based on the text from the Sermon on the Mount, "whosoever shall compel thee to go one mile, go with him twain" has established the "Second Mile Engineer" award. It is the desire of the donors to encourage undergraduates to participate fully in extra-curricular activities and to recognize the true importance of the more liberal subjects of the curriculum with the ultimate objective, on entering their profession, of becoming worthy Second Mile Engineers. The award comprises a grant of $200, a suitably inscribed presentation piece and an illuminated scroll, and is presented to a student in his final year.

An eligible group is chosen from those who have taken a prominent part in the affairs of the Faculty, either as office holders or in athletics. In making the award consideration is given to academic standing, with special emphasis on the candidate's attainments in the cultural and humanistic-social studies. The subjects which are stressed are English of the First Year; Economics of the Second Year; and Political Science and Modern World History of the Third Year.

Particulars are furnished each session by the Class of 1935.

THE SIMPSONS-SEARS LIMITED (NORTHERN ONTARIO) SCHOLARSHIPS

These scholarships, the gift of Simpsons-Sears Limited, are open only to students of the Copper Cliff High School, The Sudbury High and Technical Schools, the Sturgeon Falls High School, the North Bay Collegiate Institute and Vocational School, the Kapuskasing High School and all the Secondary Schools along the Ontario Northland Railway. A scholarship of the value of $100 is available for each of the schools mentioned and an additional sum of $50 will be given to the student who obtains the highest percentage of the nine papers of Grade XIII selected in accordance with the regulations.

No scholarship will be awarded unless the candidate is in actual attendance in one of the colleges or faculties of the University and maintains a uniformly high standard to the satisfaction of the donors of the scholarships.

Application for these scholarships must be sent not later than May 15, to the Principal of the North Bay Collegiate Institute and Vocational School, from whom further information may be obtained regarding conditions of award.

SMITH AND STONE LIMITED BURSARIES

Smith and Stone Limited, Georgetown, Ontario, have provided five Bursaries, each of a possible value of $600 and each payable at the rate of $150 per year to assist deserving students from the Georgetown High School.

The award is made annually by the Senate on the recommendation of the Council of the Faculty to a student:

(*a*) who attended Georgetown High School for at least 2 years and is recommended by the Principal;

(*b*) who has met in full the admission requirements of the Faculty, first-class honours not being a requirement.

To be eligible for continued enjoyment of the Bursary the holder must maintain satisfactory academic standing but not required to obtain honour standing.

The award was offered for the first time in the Session 1952–53.

SOCIETY OF AUTOMOTIVE ENGINEERS PRIZE

The Ontario Section of the Society of Automotive Engineers offers an annual prize of the value of $100 to a student of the Fourth Year in any course whose thesis on a topic related to Automotive Engineering is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory.

SOCIETY OF CHEMICAL INDUSTRY MERIT AWARD

The Society of Chemical Industry Merit Award is made annually by the Society to the student in Fourth Year in the Department of Chemical

Engineering who obtains the highest weighted average of marks in the results of the annual examinations for the year. The award is a gold key.

SOCONY MOBIL OIL OF CANADA LIMITED SCHOLARSHIP

Socony Mobil Oil of Canada Limited has donated a scholarship of the annual value of $400, tenable in the Third Year of either the Honours Course in Geological Sciences (Faculty of Arts and Science) or the course in Geological Engineering (Faculty of Applied Science and Engineering). Failing a suitable candidate in either of these courses, an award may be made to a student enrolled in the Third Year of either the Honours Course in Physics and Geology (Faculty of Arts and Science) or in the Geophysics Option of the course in Engineering Science (Faculty of Applied Science and Engineering).

The award is based on academic performance in the first two years of the course. Other factors, including good character, personality, breadth of interest, initiative, willingness to assume responsibility and ability to co-operate with associates, may be taken into consideration. Applications are not required.

THE MURRAY F. SOUTHCOTE SCHOLARSHIP

Established by friends of the late Murray F. Southcote, a graduate of this Faculty (Aeronautical Engineering, 1950) this scholarship, which has a value of $100, is awarded in recognition of high standing at the Annual Examinations of the Third Year, in any course in the Faculty.

The first award was made in the Session 1964–65.

THE SPECIFICATION WRITERS ASSOCIATION SCHOLARSHIP IN CIVIL ENGINEERING

Donated by the Toronto Chapter of the Specification Writers Association of Canada, this scholarship has a value of $250 and is awarded to a student who achieves high standing, with honours, in the annual examinations of the Third Year in Civil Engineering.

The first award of this scholarship was made in the Session 1961–62.

SPRUCE FALLS POWER AND PAPER COMPANY LIMITED SCHOLARSHIPS

The Spruce Falls Power and Paper Company Limited has established four Scholarships of a value of $400 each, two in the Second Year and two in the Third Year. They are awarded on the results of the Annual Examinations of the Second and Third Years to the students who obtain honour standing at the examinations of their respective years and are open to students in all courses in the Faculty. The first awards were made on the results of the examinations of 1951.

Each scholarship carries a grant of $150 to the University General Funds.

WALTER STERLING ADMISSION SCHOLARSHIPS

Established in memory of Walter Sterling, these scholarships are open to students entering any first degree course at the University of Toronto. Recipients must obtain First Class Honours standing on the nine Ontario Grade XIII papers required for admission, and may continue to enjoy the scholarships in each year of their course providing they maintain Honour standing. The value of the scholarship is from $200 to $1,500 annually, dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University on the regular scholarship application form. The statement of financial need should be completed if an award greater than $200 is desired.

THE WILLIAM STORRIE MEMORIAL SCHOLARSHIPS IN CIVIL ENGINEERING

Three Scholarships have been established by Mrs. William Storrie in memory of her husband, the late William Storrie, a Consulting Engineer on many municipal projects in Canada and for several years a special lecturer in the Faculty of Applied Science and Engineering, for students in Civil Engineering, as follows:

(*a*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Second Year in Civil Engineering.

(*b*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Third Year in Civil Engineering.

(*c*) Of a value of $200 to the student who obtains the highest standing in the annual examinations of the Fourth Year in the Municipal and Sanitary Option of the course in Civil Engineering.

In all cases the candidates shall have demonstrated qualities of integrity and shown promise of leadership in their profession.

The first awards were made for the Session 1956–57.

THE TRANE COMPANY OF CANADA LIMITED PRIZE

The Trane Company of Canada Limited has established an annual Prize of $200 in the Faculty of Applied Science and Engineering. The recipient may be registered in the Fourth Year in any course and the Prize will be awarded for the best Thesis on air-conditioning or refrigeration, either for comfort cooling or industrial use.

This award is tenable with other awards in the gift of the Senate. Application is not required.

EDITH TYRRELL MEMORIAL BURSARY

The Women's Association of the Mining Industry of Canada has presented this Bursary, having the value of $500, annually, commencing in 1939, and named in memory of their founder and first

president, Mrs. Edith Tyrrell. A medal donated by Dr. Tyrrell accompanies the Bursary. The Bursary is awarded to a student entering the Third or Fourth Year in the Course in Mining Engineering, Metallurgy and Materials Science, or Geological Engineering; it may be awarded two years in succession to the same student, but will usually be awarded at the beginning of the Third Year. The award will be made by a special committee appointed by the Association on the following basis:

(*a*) In addition to mental capacity, the student must show leadership ability and give promise, through his activities, of becoming a worthwhile influence in the affairs of the profession and the community.

(*b*) While attention is given to scholastic ability, as evidenced by his academic standing, it is not the governing factor. He must, however, stand in the top quarter of his class.

(*c*) Special consideration is given to financial need.

Application must be made to the Secretary of the Faculty within one month of the opening of the academic year.

S. UBUKATA FUND

The S. Ubukata Fund for Japanese students was established to assist students from Japan proper to pursue a course of study at the University of Toronto. The fund provides grants of varying values on the basis of the information submitted by the applicants who:

(i) must be Japanese students from Japan proper;

(ii) must register in the University of Toronto devoting full time to their studies;

(iii) are able to satisfy admission requirements regarding English facility;

(iv) are not holding other financial aid.

UNIVERSITY OF TORONTO ALUMNI ASSOCIATION WAR MEMORIAL SCHOLARSHIPS

Six scholarships are awarded annually by the University of Toronto Alumni Association to students entering first degree courses at the University of Toronto. The scholarships have a value of $500 annually, and are tenable for two years, providing satisfactory academic standing is maintained. They are awarded for general proficiency in Grade XIII, and in addition to academic performance the committee of award will take into consideration the candidate's relationship to active service in the Armed Forces of Canada, need of financial assistance, participation in extra-curricular activities and such other qualifications as may commend themselves to the committee. One scholarship will be available to a student whose home is not in the Province of Ontario.

Students resident in Ontario may apply on the general admission scholarship form which must be submitted to the Registrar of the University not later than May 1. Evidence of relationship to active service in the Armed Forces of Canada should be attached. Students resident outside Ontario may obtain the necessary forms from the Awards Department, Office of the Registrar, University of Toronto.

UNIVERSITY OF TORONTO CHEMICAL ENGINEERING CLUB SCHOLARSHIP

Provided by the University of Toronto Chemical Engineering Club, this scholarship has a value of $150 and is awarded to a student who obtains high standing in the work of the Second Year in Chemical Engineering. It is tenable only in the Third Year of the course in Chemical Engineering and may not be held with any other scholarship.

UNIVERSITY NAVAL TRAINING DIVISION BURSARIES

The University Naval Training Division Bursaries, the gift of the University Naval Training Division, are of the value of $100 each. As many as three bursaries may be awarded in each session; if fewer than three are awarded those not awarded may be given in a subsequent session. A candidate must be registered in the University for a full-time course leading to a diploma or degree and must be at the time of the award a member of one of the recognized military training units within the University. Application must be made to the University Registrar before the end of November.

UNIVERSITY OF TORONTO GENERAL BURSARIES

The Board of Governors has established a fund to provide bursaries for deserving students who without financial assistance cannot continue their formal education. Further information may be obtained from the Secretary of the Faculty.

THE U.T.S. ENGINEERING SCHOLARSHIP

The U.T.S. Engineering Scholarship, the gift of R. A. Bryce, Esq., of the value of $250. The scholarship will be awarded by a committee of the Staff of the University of Toronto Schools to a student of the Schools who has completed the requirements for admission to and enrols in the Faculty of Applied Science and Engineering.

WALLBERG ADMISSION SCHOLARSHIPS

Two admission scholarships, each of a value of $500 are awarded annually from the income from the Wallberg Bequest on the recommendation of the Council of the Faculty to the two candidates who obtain the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and

Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that this attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Applications must be submitted to the Registrar on the prescribed form by May 1.

WALLBERG UNDERGRADUATE SCHOLARSHIPS

These scholarships, four in number, of the value of $500 each, derived from the Wallberg Bequest, are awarded annually; two to students ranking first and second respectively at the annual examinations of the First Year; one to the student ranking first at the annual examinations of the Second Year; and one to the student ranking first at the annual examinations of the Third Year.

Any holder of one of these scholarships may not hold other awards listed in the index with an asterisk. The awards were first made on the result of the annual examination of 1947.

W. S. WILSON MEDALS

These medals have been provided in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal will be awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of his course.

The first awards were made in the Session 1962–63.

WILLIAM R. WORTHINGTON MEMORIAL SCHOLARSHIP

The William R. Worthington Memorial Scholarship, the gift of Miss Ida R. Worthington, in memory of her brother, William R. Worthington, Dip.(1904), B.A.Sc.(1905), of the value of the income from a fund is awarded annually to the student of the Second Year in the course in Civil Engineering who ranks highest at the annual examinations of that year.

The first award was made at the examinations for the Session 1954–55.

LOAN FUNDS

From the loan funds mentioned below, small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must accordingly be restricted, both in amount and number, and principally to students in the Third and Fourth Years.

Enquiries for loans from any of the following funds should be made at the office of the Secretary of the Faculty.

Engineering Alumni Loan Fund
Engineering Society Loan Fund
Elizabeth Speller Memorial Fund
James W. Crocker Memorial Fund
Harry F. Bennett Educational Fund
S.A.E.—Canadian Section Loan Fund
Class of 2T7 (SPS) Memorial Loan Fund
Avro Aircraft Limited Engineering Loan Fund
Association of Professional Engineers Loan Fund
The William Storrie Memorial Fund
3T6 Engineers Loan Association
4T0 Engineering Loan Fund
Women's Association of the Mining Industry in Canada Loan Fund
The Devonshire Loan Fund
Class of '09 Trust Fund
University of Toronto Alumni Loan Fund
University of Toronto General Loan Fund

CLASS OF 1936 LOAN ASSOCIATION

Members of the Class of 1936 have made arrangements to assist students in obtaining loans through regular banking facilities. Information may be obtained from the Secretary of the Faculty.

ENGINEERING ALUMNI LOAN FUND

The Engineering Alumni Association established in 1950 a loan fund to assist engineering students, especially in the Third and Fourth Years.

Applications for loans from this fund should be made to the Secretary of the Faculty.

CLASS OF 2T7 (SPS) MEMORIAL LOAN FUND

This fund was established in 1955 to memorialize the Class of 1927 of the Faculty of Applied Science and Engineering.

Loans to a total of $250 are available to any undergraduate who has completed one Year, with or without conditions, and who has qualified for the Second, Third or Fourth Year.

Application shall be made to the Secretary of the Faculty.

ENGINEERING SOCIETY LOAN FUND

In 1932 the Engineering Society repaid to the Board of Governors a series of annual grants which, over a period of years, had been made to the Society for special purposes. The Board of Governors, appreciating

this action, set aside this sum, to be known as the Engineering Society Loan Fund, to provide loans to students of the Faculty of Applied Science and Engineering. The administration of the fund is carried out by a Committee appointed by the Board. The fund is not large, and only small loans can be made to relatively few students. Further inquiries should be made at the office of the Secretary of the Faculty.

ELIZABETH SPELLER MEMORIAL FUND

Through the generosity of Dr. F. N. Speller, of the Class of 1893, the "Elizabeth Speller Memorial Fund" has been established to provide loans for worthy students of the Third and Fourth Years of this Faculty. Applications for loans from this Fund should be made to the Secretary of the Faculty.

JAMES W. CROCKER MEMORIAL LOAN FUND

This fund was established by Mrs. William Crocker in memory of her son, James W. Crocker, a graduate in Mining Engineering in 1938, who was killed in an accident in a mine in the same year.

HARRY F. BENNETT EDUCATIONAL FUND

This fund was established by subscription from members of The Engineering Institute of Canada in memory of the late Harry F. Bennett, M.E.I.C., who for six years prior to his death in 1946 was chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, and who accomplished so much in this field by untiring efforts.

One purpose of the fund is to make loans to deserving students who need financial assistance to enable them to study engineering sciences at university level, and who have proved themselves by successfully completing their first year in engineering or the equivalent.

Loans will be made largely on the basis of character and to men who seem likely to develop the high professional standards which are essential to leadership in engineering science. A student who has been aided by this fund should feel that high obligations are placed on him; obligations to the subscribers, to the trustees, and to those coming after him who in turn can receive help as his loan is repaid.

Application forms may be obtained at the Faculty Office. The regulations are simple and the application of any worth-while student will be given immediate and careful attention.

SOCIETY OF AUTOMOTIVE ENGINEERS—CANADIAN SECTION LOAN FUND

The Society of Automotive Engineers—Canadian Section has established a loan fund of $1,200 in the Faculty of Applied Science and Engineering. Preference is given to students in good scholastic standing and engaged in studies relative to the automotive and aircraft industries,

and to students in fourth, third and second years in that order. Particulars may be obtained from the Secretary of the Faculty.

AVRO AIRCRAFT LIMITED ENGINEERING LOAN FUND

Avro Aircraft Limited has established a Loan Fund of $3,000 to provide loans to engineering students requiring financial assistance. Application should be made to the Secretary of the Faculty.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO LOAN FUND

The Association of Professional Engineers has made loans not exceeding $200 available to students in the First, Second and Third Years in this Faculty. Application should be made to the Association at 236 Avenue Road, Toronto.

THE WILLIAM STORRIE MEMORIAL FUND

The William Storrie Memorial Fund has been established by Mrs. William Storrie to provide loans to undergraduates in the course in Civil Engineering. Application should be made to the Secretary of the Faculty.

THE DEVONSHIRE LOAN FUND

This Fund has been established by Graduates and friends of Devonshire House to assist students in the Residence. Application should be made to the Office of the Dean of Devonshire House.

CLASS OF '09 TRUST FUND

The Class of '09 on the 50th Anniversary of their graduation made a sum of money available in the Faculty for financial aid to undergraduates, with preference to Second Year students. Inquiry should be made to the Secretary of the Faculty.

THE UNIVERSITY OF TORONTO ALUMNI LOAN FUND

This fund comes from subscriptions received originally in 1919 and in succeeding years from graduates of the University and is administered by the University of Toronto Alumni Association.

Loans are available to undergraduate and graduate students enrolled in a full time course at the University, in second and subsequent years.

Particulars may be obtained from The University of Toronto Alumni Association, Alumni House, 18 Willcocks Street, Toronto, or from the Secretary of the Faculty or School.

GRADUATE SCHOLARSHIPS AND FELLOWSHIPS

ALUMINIUM LABORATORIES LIMITED FELLOWSHIP

The Aluminium Laboratories Ltd. have established a fellowship valued at $2,000 plus fees. This award will be held in the School of Graduate Studies by a candidate for a Master's or a Doctor's degree in the fields of mathematics or physical sciences, pure or applied, preference being given to students in the field of physical metallurgy.

THE ATHLONE FELLOWSHIPS

Her Majesty's Government in the United Kingdom has established a number of fellowships to be awarded annually to enable Canadian engineering graduates to take postgraduate training in the United Kingdom. These became available in 1951 when five fellowships were open to graduates of the University of Toronto immediately after graduation. Additional fellowships are for award to graduates who have already spent some time in industry. The fellowships cover costs of transport, fees and maintenance and are normally tenable for a period of two years. They may be utilized for (*a*) works training in industry, (*b*) postgraduate university study, or (*c*) a combination of these. Candidates must be Canadian citizens or British subjects normally resident in Canada and should preferably be less than 27 years of age. Further information and application forms may be obtained from the Secretary of the Faculty.

J. P. BICKELL FOUNDATION FELLOWSHIPS

These fellowships, of a value of $2,000 annually, are open to students registered in the School of Graduate Studies and pursuing studies in Metallurgy and Materials Science or Geological Sciences. Applications must be submitted to the Secretary of the School of Graduate studies not later than March 1.

THE C.I.L. FELLOWSHIPS

Two fellowships, the gift of Canadian Industries (1954) Limited, of the value of $2,000 each are established for the encouragement of postgraduate work in Chemistry. An applicant must be a university graduate who is a Canadian citizen or a graduate who intends to follow a career in Canada, with preference to Canadian citizens. The holders of these Fellowships will be required to undertake research in any branch of Chemistry under the direction of the department designated by the Committee of Award. Application must be made, with full statement of qualifications and testimonials, to the Secretary of the School of Graduate Studies not later than March 1.

CANADIAN LUMBERMEN'S ASSOCIATION TIMBER RESEARCH FELLOWSHIP

This fellowship, donated by the Canadian Lumbermen's Association, is offered to encourage advanced study and research in timber engineering. It is open to graduates in engineering and graduates in forestry of any recognized university. The fellow must be registered in the School of Graduate Studies as a student proceeding to a postgraduate degree and must carry out a prescribed programme of study and research in both engineering and forestry. It is intended that the work of this programme will extend over a period of two academic years. The annual value of the fellowship is $1,250, all of which might not be granted to one student.

Application should be made to the Secretary of the School of Graduate Studies not later than September 1 and should be accompanied by an official transcript of the applicant's undergraduate record, together with a statement of his experience in the forestry and construction fields.

COMMONWEALTH SCHOLARSHIPS

Under a Plan drawn up at a conference held in Oxford in 1959, each participating country of the Commonwealth offers a number of scholarships to students of other Commonwealth countries. These scholarships are mainly for graduate study and are tenable in the country making the offer. Awards are normally for two years and cover travelling, tuition fees, other university fees, and a living allowance.

For details of the awards offered by the various countries consult the Registrar's Office, or write to The Canadian Universities Foundation, 75 Albert Street, Ottawa.

CONSOLIDATED MINING AND SMELTING COMPANY GRADUATE RESEARCH FELLOWSHIPS

The Consolidated Mining and Smelting Company of Canada Limited offers 10 graduate research fellowships of a value of $3,000 each ($2,200 to the student and $800 to the University) to graduates in pure or applied science or agriculture for research leading toward a higher academic degree at a Canadian university. The subject of the research shall be in some field of pure or applied science related to the broad chemical interests of the Company in the fields of Mining, Geology, Metallurgy, Chemistry, Chemical Engineering, Physics, Agriculture, and Electrical, Mechanical and Civil Engineering. Applications must be made on forms available from the Registrar's Office and submitted to the Director of Awards, Canadian Universities Foundation, 75 Albert Street, Ottawa 4, not later than February 1 in the year for which the application is made.

THE 1851 EXHIBITION SCIENCE RESEARCH SCHOLARSHIPS

The Royal Commissioners for the Exhibition of 1851 offer three scholarships valued at £750 each, to Canadian students each year. These

awards are supplemented by a grant of £250 per annum from the National Research Council of Canada, which does not affect the basic stipend or any travel allowance which may be granted by the Commissioners.

Each candidate recommended must be a British subject, and under twenty-six years of age except in very special circumstances; he must have been a student of science in a university institution for a period of not less than three years and must have spent one full academic year at this University ending not more than twelve months prior to the date of recommendation.

The record of a candidate's work must indicate high promise of capacity for advancing science or its applications by original research. Evidence of this capacity, which is the main qualification for the scholarship, is strictly required. The most suitable evidence is a satisfactory account by the candidate of research work already performed, and the Commissioners will decline to consider the claims of a candidate unless such an account is furnished, or unless there is other equally distinct evidence that he possesses this qualification.

The scholar will be required to devote his whole time to research in some branch of pure or applied science at an institution in the United Kingdom or abroad, selected with the approval of the Commissioners.

The following are the departments of the University, the students of which are eligible to apply for these scholarships: 1, Bacteriology; 2, Biochemistry; 3, Botany; 4, Chemistry; 5, Engineering (chemical); 6, Engineering (civil); 7, Engineering (electrical); 8, Engineering (mechanical); 9, Engineering (metallurgical); 10, Engineering (mining); 11, Forestry; 12, Geological Sciences; 13, Physics; 14, Physiology; 15, Zoology.

A student shall not be deemed to be ineligible because of his being on the staff of the university, if he has not been in receipt of a salary of more than $800 per annum and the nominating board may, at its discretion, recommend candidates who have been in receipt of larger salaries provided that all other conditions are fulfilled.

A student shall be deemed to be eligible in the year in which he intends to graduate, but if nominated for the scholarship his nomination shall be subject to his being successful in passing his examination for his degree.

The nominating board is appointed by the Senate and has power to call to its aid as assessor any member of the teaching staff.

Applications for these scholarships must be submitted not later than March 1 to the University Registrar from whom copies may be obtained of the general regulations of the Commissioners governing the award and tenure of the scholarship.

LACHLAN GILCHRIST FELLOWSHIP FUND

This fund provides four fellowships to the value of the available income from the capital sum of $137,000, to be awarded to graduate students in fundamental physics who enrol in the School of Graduate Studies at the University of Toronto.

Applications should be submitted to the Secretary of the School of Graduate Studies by March 1 annually.

THOMAS H. HOGG OVERSEAS FELLOWSHIP

This fellowship was established by Mrs. T. H. Hogg in 1962, in memory of the late Thomas H. Hogg, B.A., C.E., D.Eng., an honour graduate of the Faculty of Applied Science and Engineering. It is to be awarded to a Canadian candidate for study, beyond the North American continent, in the field of hydraulics, fluid mechanics or power system engineering.

Annual value of the fellowship is $2,250 with an allowance for travel and tuition to a maximum of $750. Application should be made before January 1 to the Dean, Faculty of Applied Science and Engineering.

IMPERIAL OIL GRADUATE RESEARCH FELLOWSHIPS

Imperial Oil Limited offers annually five graduate research fellowships in order to promote and encourage academic research in the technical and administrative aspects of industry, and public interest within Canada in the further advancement of knowledge.

Three fellowships are offered in Pure and Applied Natural and/or Exact Sciences, including Mathematics; two are offered in the Social Sciences and Humanities.

Tenable at Canadian and other Universities, the fellowships are valued at $2,500 each per annum. A fellow may not hold other awards equalling or exceeding $1,500 annually.

Application forms may be obtained from the Office of the Registrar and should be returned to the Secretary of the Imperial Oil Committee on Higher Education, 111 St. Clair Avenue West, Toronto 7, not later than March 1 for the following session.

THE INTERNATIONAL NICKEL GRADUATE RESEARCH FELLOWSHIPS

The International Nickel Company of Canada has established a number of Graduate Research Fellowships, to promote and encourage research in the technical fields serving the Canadian metal industries and to further public interest in industrial science in Canada. Each has a possible tenure of three years with an annual payment of $3,000, of which $2,500 is payable to the fellow and $500 is placed at the disposal of the directing professor for necessary materials or equipment. It is expected that four new fellowships will be awarded in 1961.

Applications on behalf of competent graduate students will be considered from any Canadian university qualified to confer the Master's or Doctor's degree in Geology (including Geophysics), Mining, Ore Dressing, Metallurgy (both process and physical), Chemistry (pertaining to metals), Physics (pertaining to metals), and Mathematics. Awards are made by a committee appointed by the National Conference of Canadian Universities and Colleges.

Application is made through the University department concerned to the International Nickel Company of Canada, Limited, 55 Yonge Street, Toronto 1, Ontario, not later than February 14.

JOHNSON'S WAX FUND SCHOLARSHIP

The Johnson Foundation through S. C. Johnson and Son Limited, Brantford, Ontario, offers one scholarship each year for study in a United States College or University in postgraduate fields of study such as economics, business administration, chemistry, engineering, teaching, etc. The amount of the scholarship varies according to the requirements of each student.

Further information and preliminary application forms which must be submitted to the company not later than December 15 may be obtained from the Registrar of the University.

MC CHARLES PRIZE

This prize, the gift of the late Æneas McCharles of the value of $1,000, is awarded from time to time but not necessarily every year on the following terms and conditions: (1) to any Canadian from one end of the country to the other, and whether student or not, who invents or discovers any new and improved process for the treatment of Canadian ores or minerals of any kind, after such process has been proved to be of special merit on a practical scale; (2) or for any important discovery, invention or device by any Canadian that will lessen the dangers and loss of life in connection with the use of electricity in supplying power and light; (3) or for any marked public distinction achieved by any Canadian in scientific research in any useful practical line. The following conditions determine the method of award.

(1) The title shall be the McCharles Prize.

(2) The value of the prize shall be One Thousand Dollars ($1,000) in money.

(3) Every candidate for the prize shall be proposed as such in writing by some duly qualified person. A direct application for a prize shall not be considered.

(4) The composition of the awarding body shall be as follows:

An expert in Mineralogy,
An expert in Electricity,
An expert in Physics,

and four other persons. All of the members of this body shall be nominated by the Board of Governors of the University of Toronto.

THE UNIVERSITY OF MANCHESTER TORONTO FUND

The University of Manchester has accepted the gift of a sum of £1,699 from a Committee representing the parents of children who during the war were evacuated to Toronto and other places in Canada. The capital and any income arising therefrom will be used to make

grants to Canadians wishing to conduct postgraduate studies and/or research in the University of Manchester, preference being given to stduents who have graduated from the University of Toronto. The total amount of grant or grants to any student will not exceed £100. Applications must be submitted to the Registrar of the University of Toronto on or before January 1 of the year in which the applicant wishes to enter the University of Manchester, together with transcripts of undergraduate and graduate record and outlines of the postgraduate studies and/or research to be followed at the University of Manchester.

NATIONAL SEWER PIPE COMPANY LIMITED SCHOLARSHIP

The National Sewer Pipe Company Limited has established a scholarship of a value of $500 in the School of Graduate Studies. It is awarded annually to a student who undertakes to enrol in that School, proceeding to the degree of Master of Applied Science in the graduate Department of Civil Engineering and in the course in Public Health Engineering.

Applications must be submitted to the Secretary of the School of Graduate Studies on or before March 1.

NIPISSING MINING COMPANY RESEARCH FELLOWSHIP

The Nipissing Mining Company has endowed a Research Fellowship in Mining Engineering, to be known as The Nipissing Mining Company Research Fellowship, of the annual value of the income from the fund, plus free tuition.

This Fellowship is open to graduates of any University.

H. W. PRICE RESEARCH FELLOWSHIP IN ELECTRICAL ENGINEERING

The H. W. Price Research Fellowship in Electrical Engineering consisting of the income or a part thereof but not exceeding the income for three years derived from the sum of $10,000 donated by the Hydro-Electric Power Commission of Ontario, will be awarded from time to time as recommended by the School of Engineering Research, to a graduate in Electrical Engineering of any recognized University, registered in the School of Graduate Studies, wishing to proceed with an investigation in the field of Electrical Engineering.

Forms of application may be obtained from the Secretary, School of Graduate Studies, and should be returned with a statement of qualifications not later than March 1. The first award was available in 1943.

THE RAYMOND PRIESTLEY FELLOWSHIP

The University of Birmingham being "anxious to mark its indebtedness and its gratitude" for the hospitality shown during the Second World War to children of members of its teaching staff by members of the University of Toronto, has set aside a research fellowship to be held by a graduate of the University of Toronto. This fellowship, to be

known as the Raymond Priestley Fellowship, of the value of £450 per annum as well as the cost of the return passage from Canada, is available for graduates, both men and women, preferably those who have already shown some capacity for and interest in research. The fellowship will normally be awarded for a period of three years. It is tenable in any faculty of the University of Birmingham. The Fellow will undertake research and may, if he wishes, be a candidate for a higher degree at the University of Birmingham. The selection of the candidate will be made by the University of Toronto. The process of selection will include negotiation with the head of the department concerned in the University of Birmingham to ensure that there is in the University opportunity for the pursuit of the particular line of research required. Applications must be submitted to the University Registrar not later than March 1, together with transcripts of undergraduate and graduate records and outlines of the research to be undertaken at the University of Birmingham.

THE ROYAL INSTITUTION OF GREAT BRITAIN SCIENCE RESEARCH SCHOLARSHIPS

A scholarship of the value of £350 per annum with a possible additional allowance of £50, to be held ordinarily for a period of two years, will be offered each year to a candidate from one of the universities of Canada, Australia, New Zealand and South Africa, and is tenable only in the Davy Faraday Research Laboratory of the Royal Institution, London. No candidates will be considered except those who have been recommended for the 1851 Exhibition Science Research scholarships, and candidates who wish to be considered also for the Royal Institution scholarships are requested to state this clearly in the application for an 1851 scholarship. No other application to the Royal Institution is necessary. Copies of the regulations relating to these scholarships may be obtained from the University Registrar.

THE STEEL COMPANY OF CANADA LIMITED FELLOWSHIPS IN METALLURGY

Four Fellowships, each of the value of $3,000, out of which $2,000 will be awarded to the successful candidate and $1,000 to the university at which he or she studies, are offered to permanent residents of Canada who are graduates of a Canadian university. The fellowships are normally tenable for one year but in special circumstances may be renewed for a second year. Applications must be made in triplicate on the approved form to The Secretary, Canadian Universities Foundation, 75 Albert Street, Ottawa. Forms may be obtained from the relevant department in your university, from the Registrar's office, or from the above address.

SPRUCE FALLS POWER AND PAPER COMPANY, LIMITED, FELLOWSHIP

The Spruce Falls Power and Paper Company Limited has established a Fellowship for the encouragement of research in the Faculty, of an

annual value of $1,200. It is open to graduates of the University of Toronto or of other recognized universities, but is restricted to Canadian citizens. Applications should be sent to the Secretary of the School of Graduate Studies, not later than March 1.

The Fellowship also carries a grant of $300 to be applied to the tuition of the holder and $300 to the general University Funds.

THE 1940 TORONTO FUND

The 1940 Toronto Fund, the gift of Oxford University, of the value of £3,000, was set up in 1940 by the parents of Oxford children who were taken into Canadian and American homes during the War. Recommendations for grants from the Fund will be made from time to time by the Senate of the University of Toronto to members of the University "who wish to go to Great Britain for the purpose of study, research, or any general educational purpose, taking education in the widest possible sense." Each applicant for a grant from this Fund must submit his application to the University Registrar not later than March 1 together with an outline of the study or research which he proposes to undertake in Great Britain, or the general educational purpose which he has in mind in going there.

WALLBERG RESEARCH FELLOWSHIPS

Three Wallberg Research Fellowships, each of the value of $2,500, are open to graduates of any recognized university who propose to pursue advanced study and research in any branch of Engineering in the University of Toronto.

Forms of application may be obtained from the Secretary of the School of Graduate Studies. These should be returned together with a transcript of academic record and an outline of the proposed study and research not later than March 1.

THE CHARLES G. WILLIAMS FELLOWSHIP IN URANIUM METALLURGY

Eldorado Mining and Refining Limited offers a postgraduate scholarship in Uranium Metallurgy to a graduate in the physical sciences, pure and applied, of a value of $1,500 for an academic year and the holder is also eligible for a supplementary amount of $800 for the summer months. A cash grant to the University accompanies the fellowship.

Application forms may be obtained from the Registrar of the University and submitted to the Secretary, Eldorado Mining and Refining Limited, P.O. Box 379, Ottawa, Ontario, before March 15.

SECTION XI. DISCIPLINE

A SUMMARY OF THE REGULATIONS OF THE CAPUT CONCERNING STUDENT DISCIPLINE

1. Subject to the general regulations of the Caput of the University regarding jurisdiction in matters of discipline the Council of University College, the governing bodies of the Federated Universities and Affiliated Colleges, and the Councils of the Faculties, Schools, and Institutes have disciplinary jurisdiction over the conduct of all students registered in these Divisions of the University in all matters of local or internal concern to these Divisions. Jurisdiction over the conduct of students while in residence regardless of the Division of the University in which they are registered is vested in the body administering the residence.

2. Jurisdiction concerning conduct likely to affect the interests of the University as a whole is vested in the Caput.

3. The Students' Administrative Council will be supported in the proper performance of all its obligations and duties as provided in its Constitution.

4. Where the appropriate body exercising disciplinary jurisdiction has found that a student of the University has engaged in conduct prejudicial to the interests of the University, the Caput may, in its discretion, suspend or expel such student from the academic privileges of the University. Every decision of the Caput involving the expulsion of a student from the University requires confirmation of the Board of Governors.

5. Any student who interferes with the personal liberty of another or who subjects another student to indignity or personal violence may be considered by the Caput or any other body exercising disciplinary jurisdiction in the University to have committed a breach of discipline.

6. Initation ceremonies involving physical violence, personal indignity, interference with personal liberty, or destruction of property, may be deemed a breach of discipline by the Caput or any other body exercising disciplinary jurisdiction in the University.

7. Without limiting the disciplinary powers vested in the respective bodies exercising disciplinary jurisdiction as set forth in sections 1–7, the following are cited as illustrations of conduct which, in the past, has been considered a breach of discipline prejudicial to the interests of the University:

(i) The organising of a parade on the streets of the city or the taking part in such a parade without permission of the authorities.

(ii) The destruction or defacing of University property, raids on Residences or other University buildings, and the breaking into University buildings.

(iii) Rowdy and other forms of behaviour, either on or off the Campus, of such an objectionable nature as to bring the University into public disrepute.

8. Student Clubs and Associations

(a) The constitution of every society or association of students in the University and all amendments to such constitutions require to be approved by the relevant University authorities. The giving of approval, and the responsibility for the programmes of student societies and associations, shall rest as follows:

(i) With the authorities of the College, Faculty or School concerned where the membership of the student society or association is drawn from a single College, Faculty or School.

(ii) With the Board of Stewards of Hart House, where the student society or association is a Committee of Hart House and is controlled by the Board of Stewards of Hart House.

(iii) With the Caput, in the case of all other student societies and associations.

(b) No approval will be given by any of the authorities listed in (a) above to the constitution of any society or association of students if that constitution permits:

(i) Membership in the society or association to persons who are not students of the University, unless in the case of the societies listed in (a) (ii) above, where membership is open also to graduates of the University and members of the Faculty of the University.

(ii) Any action of discrimination based upon race, religion, or colour.

9. The name of the University is not to be used in connection with a publication of any kind without permission of the Caput.

SUMMARY OF STUDENTS IN ATTENDANCE

Session 1964–65

Courses		1	2	3	4	5	6	7	8	9	Total
Year	I	80	2	53	36	81	128	84	12	12	488
	II	50	3	69	49	50	99	99	10	9	438
	III	47	8	52	35	45	56	65	14	4	326
	IV	55	7	31	19	43	40	53	11	5	264
TOTAL		232	20	205	139	219	323	301	47	30	1516
Special Students											9
Diploma Course in Operations Research											5
											1530

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UNIVERSITY OF TORONTO

CALENDAR



Faculty of Applied Science
and Engineering

1966-1967

UNIVERSITY OF TORONTO PRESS
1966

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FALL TERM, 1966

July 1	*Friday*	Dominion Day. Buildings closed.
August 1	*Monday*	Civic Holiday. Buildings closed.
August 15	*Monday*	Students of the III Year, Course 1, report at Survey Camp.
August 22	*Monday*	Students of the IV Year, Course 1, Option B, report at Survey Camp.
September 5	*Monday*	Labour Day. Buildings closed.
September 6	*Tuesday*	Fall Examinations commence.
		Students of the III Year, Course 9, report at Survey Camp.
September 7	*Wednesday*	Students in II Year, Course 6, report for Analytical Chemistry Laboratory.
September 15	*Thursday*	Registration in person of the I Year from 9:30 a.m. to 12 noon and from 2:00 p.m. to 4:30 p.m. in the Galbraith Building.
		Meeting of Faculty Council.
September 16	*Friday*	Registration in person of the II Year from 9:30 a.m. to 12 noon and of the III Year from 2:00 p.m. to 4:30 p.m. in the Galbraith Building.
		Dean's address to the I Year at 9:00 a.m. in Convocation Hall.
		Preliminary instruction to the I Year.
September 17	*Saturday*	Registration in person of the IV Year from 9:30 a.m. to 12 noon in the Galbraith Building.
September 19	*Monday*	Lectures and laboratory work commence at 9:00 a.m.
		Opening address by the President to the students of all Faculties at 2:15 p.m. in Convocation Hall. Lectures and laboratory classes withdrawn from 2:00 p.m.
October 4	*Tuesday*	Meeting of Faculty Council.
October 10	*Monday*	Thanksgiving Day. Buildings closed.
October 14	*Friday*	Meeting of Senate.
November 2	*Wednesday*	Meeting of Faculty Council.
November 11	*Friday*	Remembrance Day Service 10:30 a.m. Lectures and laboratory classes withdrawn from 10:00 a.m. to 11:15 a.m.
		Meeting of Senate.
November 25	*Friday*	Fall Convocation.
December 1	*Thursday*	Meeting of Faculty Council.

December 9	*Friday*	Meeting of Senate.
December 19	*Monday*	First Year Term Examinations commence.
December 21	*Wednesday*	Term ends at 5 p.m.
December 25	*Sunday*	Christmas Day. Buildings closed.

SPRING TERM, 1967

January 1	*Sunday*	New Year's Day. Buildings closed.
January 4	*Wednesday*	Spring term begins, Mid-session Examinations commence.
January 11	*Wednesday*	Meeting of Faculty Council.
January 13	*Friday*	Meeting of Senate.
January 16	*Monday*	Last day for receiving the second term instalment of fees.
January 19	*Thursday*	IV Year Employment interviews.
January 20	*Friday*	IV Year Employment interviews.
January 21	*Saturday*	IV Year Employment interviews.
February 2	*Thursday*	Meeting of Faculty Council.
February 10	*Friday*	Meeting of Senate.
February 20 to February 25	*Monday* *Saturday*	Study week. Lectures and laboratory classes withdrawn.
March 1	*Wednesday*	Meeting of Faculty Council.
March 10	*Friday*	Meeting of Senate.
March 24	*Friday*	Good Friday. Buildings closed.
April 3	*Monday*	Meeting of Faculty Council.
April 14	*Friday*	Term ends at 5 p.m. Meeting of Senate.
April 24	*Monday*	Annual Examinations commence.
May 3	*Wednesday*	Meeting of Faculty Council.
May 12	*Friday*	Meeting of Senate.
May 22	*Monday*	Victoria Day. Buildings closed.
May 29 to June 6	*Monday* *Tuesday*	Convocations.

ADMINISTRATIVE OFFICERS

1965–66

THE UNIVERSITY

President . . . . . C. T. Bissell, M.A., Ph.D., D.Litt., LL.D., F.R.S.C.
Executive Assistant to the President . . . . . D. F. Forster, B.A., A.M.

Vice-President and Provost . . . . . M. St. A. Woodside, M.A., LL.D.
Vice-Provost . . . . . J. H. Sword, M.A.

Vice-President (Research Administration)
G. de B. Robinson, M.B.E., B.A., Ph.D., F.R.S.C.

Vice-President for Scarborough and Erindale Colleges and Principal of Erindale College . . . D. C. Williams, M.A., Ph.D.

Chief Librarian . . . . . R. H. Blackburn, M.A., B.L.S., M.S., LL.D.

Vice-President (Administration) . . . . . F. R. Stone, B.Com., C.A.
Director of Finance . . . . . G. L. Court, D.F.C., M.Com., C.A.
Secretary of the Board of Governors and Director of Administrative Services . . . . . D. S. Claringbold
Director of Physical Plant . . . . . F. J. Hastie, B.Sc., P.Eng.

Registrar and Director of Student Services . . . . R. Ross, M.B.E., M.A.
Director of Admissions . . . . . E. M. Davidson, B.A.
Director of Financial Aid . . . . . R. L. Purves, D.S.O., C.D., B.A.
Special Officer (Secondary School Liaison)
J. R. H. Morgan, M.B.E., M.A., B.Paed., LL.D.
Director of Statistics and Records . . . . J. M. Tusiewicz, M.A.Sc., M.B.A.
Director of University Health Service . G. E. Wodehouse, M.C., M.D., F.R.C.P.
Assistant Director of University Health Service—Women
Miss F. H. Stewart, B.A., M.D.
Director of Placement and Housing Services . J. K. Bradford, O.B.E., M.A.Sc.
Director of International Student Centre . . . . . Mrs. K. Riddell, B.A.
Director of the Advisory Bureau
D. J. McCulloch, B.A., M.D., D.Psych., F.R.C.P.

Director of University Extension . . . . . G. H. Boyes, M.A.

Director of University of Toronto Press . . . . . M. Jeanneret, B.A.

Director of Information . . . . . K. S. Edey
Director of Alumni Affairs . . . . . J. C. Evans, B.A.
Director of Development . . . . . R. J. Albrant

Warden of Hart House (Acting) . . . . . E. A. Wilkinson, B.A.
Director of Athletics and Physical Education—Men . . W. A. Stevens, B.S.
Director of Athletics and Physical Education—Women (Acting)
Miss D. Jackson, B.Sc., M.A.
Director of Hart House Theatre . . . . . R. S. Gill, M.A.

SECTION III. FACULTY STAFF

1966–67

ADMINISTRATIVE STAFF

Dean . . . . . J. M. Ham, B.A.SC., S.M., SC.D.
Associate Dean . . . . . W. F. Graydon, M.A.SC., PH.D.
Assistant Dean and Secretary . . . . . J. A. Gow, B.A.SC.
Assistant Secretary . . . . . W. H. Sisson, B.A.SC.

TEACHING STAFF

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY:

Professor and Head of the Department: J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.).

Professors: W. F. Graydon, M.A.SC., PH.D.(MINN.); W. G. MacElhinney, M.A.SC.; R. R. McLaughlin, M.A.SC., M.A., PH.D.; W. H. Rapson, M.A.SC., PH.D.; M. Wayman, M.A., PH.D.; *Professor of Nuclear Engineering*: D. G. Andrews, M.A.(CANTAB.).

Associate Professors: D. Basmadjian, DIP.ING.CHEM.(ZURICH), M.A.SC., PH.D.; W. H. Burgess, B.CH.E., M.F.S., PH.D.(CORN.); R. L. Hummel, B.S.(PURDUE), PH.D.(IOWA); R. E. Jervis, M.A., PH.D.; R. W. Missen, M.SC.(QU.), PH.D.(CANTAB.); S. Sandler, M.A.SC.; I. H. Spinner, M.A.SC., PH.D.; O. Trass, B.S.E.(PRINC.), SC.D.(M.I.T.); *Associate Professor of Mining Engineering*: W. A. M. Hewer, B.A.SC.

Assistant Professors: M. E. Charles, B.SC.(LOND.), M.SC., PH.D.(ALTA.); R. Luus, M.A.SC., PH.D.(PRINCETON); J. W. Smith, M.A.SC.(U.B.C.), PH.D.(LOND.).

Lecturer: C. C. Barnes, B.SC.(QU.); J. Binkiewicz, DIP.CHEM.ENG.(LWOW); Z. May, DIP.ING.CHEM.(WARSAW); Miss M. J. Phillips, B.A.SC., M.A.(BRYN MAWR), PH.D.(J.H.U.); A. Rozieu, DIP.ING.(BUCHAREST).

Special Lecturers: C. P. Brockett, B.SC.(M.I.T.); ~~H. D. Sharma,~~ M.SC.(DELHI), PH.D.(CAL.).

DEPARTMENT OF CIVIL ENGINEERING:

Professor and Head of the Department: C. F. Morrison, B.E.(SASK.), M.SC.(MCG.).

Professors: C. E. Helwig, m.a.sc.; M. W. Huggins, m.a.sc.; G. Kani, dr.ing.(stuttgart); O. J. Marshall, b.a.sc., c.e., o.l.s.

Associate Professors: J. D. Barber, m.a.sc.; A. P. Bernhart, dip.ing. (graz.), dr.tech.(graz.); R. A. Collins, b.a.sc., m.s.(ill.), ph.d.(ill.); A. C. Davidson, b.sc., c.e., b.sc., e.e.(man.), m.a.sc.; M. M. Davis, b.sc.(qu.), m.sc.(purdue); F. A. De Lory, b.eng. (mcg.), m.a.sc., d.i.c.(imp.), ph.d.(lond.); H. R. Frizzle, b.sc., e.e.(n.s.tech.); B. J. Haynes, b.a.sc., o.l.s.; C. Hershfield, b.sc., c.e.(man.), m.a.sc.; D. J. L. Kennedy, b.a.sc., m.s.(ill.), ph.d.(ill.); H. L. Macklin, b.a.sc., o.l.s., d.l.s.; E. I. Robinsky, b.a.(beirut), b.sc.(beirut), m.s.(harvard), ph.d.; J. Schwaighofer, dip.ing(graz.), m.s.(penn. st.), ph.d.(penn. st.), dr.tech. (graz.); R. M. Soberman, b.sc.(dalh.), s.m.(m.i.t.), ph.d.(m.i.t.); C. A. Wrenshall, b.e.(sask.).

Assistant Professors: S. J. G. Bird, m.a.sc.,o.l.s.; R. C. Gunn, m.a.sc.; G. W. Heinke, m.a.sc.; P. H. Jones, b.a.sc., ph.d.(northwest.); I. C. Medland, b.e.(auck.), m.e.(auck.), b.sc.(auck.), ph.d. (manch.); K. Meipoom, m.a.sc.; K. A. Selby, b.a.sc., m.b.a., ph.d.(ill.); J. Timusk, m.a.sc.; S. M. Uzumeri, m.a.sc.; J. Vlcek, b.sc.f.(n.b.), m.a.sc.; G. T. Will, m.a.sc.

Lecturers: V. P. Borecky, dipl.ing.(prague), m.a.; E. Karuks, m.a.sc.; R. G. Tress, b.a.sc.

Special Lecturers: W. E. Carswell, b.arch.; D. M. Hill, m.a.; M. G. Tallon, b.a.sc.; P. Wodzianski, mgr.ph.(warsaw).

DEPARTMENT OF ELECTRICAL ENGINEERING:

Professor and Head of the Department: G. R. Slemon, b.a.sc., m.a.sc., d.i.c.(imp.coll.), ph.d.(lond.).

Associate Professor and Assistant Head of the Department: W. Janischewskyj, b.a.sc., m.a.sc.

Professors: P. P. Biringer, dip.ing.(bud.), m.sc.(stockholm), ph.d.; J. M. Ham, b.a.sc., s.m.(m.i.t.), sc.d.(m.i.t.); N. F. Moody, b.sc.(sask.); J. E. Reid, b.a.sc.; G. Sinclair, b.sc.(alta.), m.sc. (alta.), ph.d.(ohio state); V. G. Smith, b.a.sc.

Associate Professors: P. E. Burke, b.e.(n.s.tech.), m.a.sc.; R. C. Cobbold, b.sc.(lond.), m.sc.(sask.), ph.d.(sask.); G. W. Dick, b.a.sc., m.a.sc., ph.d.; V. L. Henderson, b.a.sc., a.m.(mich.); A. J. Kravetz, b.sc.(alta.), m.a.sc.; G. R. Lang, b.sc.(u.w.o.); I. McCausland, b.sc.(q.u.belfast), m.sc.(q.u.belfast), ph.d. (cantab); H. W. Smith, b.a.sc., sc.d.(m.i.t.); K. C. Smith, b.a.sc., m.a.sc., ph.d.; A. Straughen, b.sc.(lond.), m.a.sc.; J. L. Yen, b.sc.(chiao tung), m.a.sc., ph.d.

Assistant Professors: K. G. Balmain, b.a.sc., m.s.(ill.), ph.d.(ill.); H. A. Courtice, b.a.sc.; Miss M. G. Currie, b.a.sc.; I. R. Dalton, b.a.sc., m.s.(northwest); E. J. Davison, a.r.c.t., b.a.sc., m.a., ph.d.(cantab); S. Dmitrevsky, m.a.sc., a.m.(harvard), ph.d. (harvard); E. S. Lee, b.eng.(mcg.), m.eng.(mcg.), ph.d.; S. D. T. Robertson, b.sc.(queen's), d.i.c.(imp.coll.), m.a.sc., ph.d.

Lecturers: R. T. H. Alden, b.a.sc., m.a.sc.; P. I. Boulton, b.a.sc., m.a.sc., ph.d.; N. C. McDermott, b.a.sc., m.a.sc.

Instructor: Mrs. S. Mosher, e.e.(odessa), m.a.sc.

DEPARTMENT OF ENGINEERING SCIENCE:

Head of the Department: V. G. Smith, b.a.sc. (Professor of Electrical Engineering)

Members of the Department: B. Etkin, m.a.sc., f.c.a.s.i. (Professor of Aeronautics and Astronautics); W. F. Graydon, m.a.sc., ph.d. (minn.) (Professor of Chemical Engineering); T. E. Hull, m.a., ph.d. (Professor of Mathematics); G. D. Scott, m.a., ph.d. (Professor of Physics); W. C. Winegard, m.a.sc., ph.d. (Professor of Metallurgical Engineering).

DEPARTMENT OF INDUSTRIAL ENGINEERING:

Professor and Head of the Department: A. Porter, m.sc., ph.d. (manch.).

Associate Professors: J. W. Abrams, a.b., ph.d.(calif.); R. W. P. Anderson, m.a.sc.; B. Bernholtz, m.a., ph.d.(cal.i.t.); D. J. Clough, b.a.sc., m.b.a.; S. Kotz, m.sc., ph.d.(cornell).

Visiting Associate Professor: J. G. C. Templeton, a.m., ph.d.(princeton).

DEPARTMENT OF MECHANICAL ENGINEERING:

Professor and Head of the Department: G. R. Lord, b.a.sc., s.m.(m.i.t.), ph.d.

Professors: W. D. Baines, b.sc.(alta.), m.s., ph.d.(iowa); F. C. Hooper, b.a.sc., d.i.c.(lond.); L. E. Jones, b.sc.(c.e.)(man.), m.a.sc., ph.d.; I. W. Smith, m.a.sc.

Associate Professors: A. B. Allan, m.a.sc.; P. B. Hughes, b.sc.(mcg); H. J. Leutheusser, dipl.ing.(karlsruhe), m.a.sc., ph.d.; C. H. Miller, b.e.(n.s. tech.), m.a.sc., ph.d.; F. P. J. Rimrott, dipl. ing.(karlsruhe), m.a.sc., ph.d.(penn.state), dr.ing.; R. T. Waines, b.a.sc.; W. A. Wallace, b.a.sc.

Assistant Professors: B. M. M. Carpendale, m.a.(cantab); G. E. Godfrey, m.a.sc.; B. H. Karnopp, s.b.(m.i.t.), sc.m.(brown), ph.d.(wis.); J. F. Keffer, m.a.sc., ph.d.; W. J. Moroz, m.a.sc., ph.d.(mich.); J. VandeVegte, dipl.ing.(delft), m.a.sc., ph.d.

Lecturers: D. L. Allen, b.sc.(dal.), b.e.(n.s.tech.), m.a.sc.

Special Lecturers: J. P. Bruce, m.a.; F. E. Burke, b.a.(lond.).

Instructors: A. Eidlitz, m.a.sc.; R. P. Henry, m.a.sc.; J. G. Lenard, m.a.sc.; V. G. Loscombe, b.a.sc.; C. B. Rorke, b.sc.(mcg.).

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE:

Professor and Head of the Department: L. M. Pidgeon, m.b.e., b.sc.(oxon.), ph.d.(mcg.), f.r.s.c.

Professors: G. B. Craig, m.a.sc., ph.d.; W. C. Winegard, m.a.sc., ph.d.; S. N. Flengas, b.sc.(athens), d.i.c.(lond.).

Associate Professor: H. U. Ross, c.d., m.sc.(mcg.).

Assistant Professors: B. Ramaswami, ph.d.(harvard); J. Carruthers, m.a.sc., ph.d.

DEPARTMENT OF MINING ENGINEERING:

Professor and Head of the Department: H. R. Rice, b.sc.(qu.).

Professor: S. E. Wolfe, m.a.sc., p.eng.

Special Lecturer: I. A. B. Low, ph.d.(lond.), a.r.s.m.

Instructor: W. J. Riddell, b.sc.(qu.).

INSTITUTE FOR AEROSPACE STUDIES:

Professor and Director of the Institute: G. N. Patterson, b.sc.(alta.), m.a., ph.d., ll.d., d.sc., f.r.ae.s., f.c.a.s.i., f.a.i.a.a., f.r.s.c.

Professors: J. H. de Leeuw, dip.ing.(delft), m.s. in a.e.(georgia tech.), ph.d.; B. Etkin, m.a.sc., f.c.a.s.i.; I. I. Glass, m.a.sc., ph.d., f.a.p.s., f.c.a.s.i.; H. S. Ribner, b.s.(cal. tech.), m.s., ph.d.(wash.), f.a.s.a., f.c.a.s.i.

Associate Professors: J. B. French, B.A.SC., M.SC.(BIRMINGHAM), PH.D.; G. K. Korbacher, DIP.ING.(BERLIN), PH.D.(BRAUNSCHWEIG).

Assistant Professors: R. C. Tennyson, M.A.SC., PH.D.; S. J. Townsend, B.A.(SASK.), M.A.(SASK.), PH.D.; R. M. Measures, B.SC., A.R.C.S., D.I.C., PH.D.(LOND.); P. A. Sullivan, B.E., M.E.(N.S.W.), D.I.C., PH.D. (LOND.).

Special Lecturers: I. J. Billington, B.A.SC., M.A.SC.(U.B.C.), PH.D.; R. D. Hiscocks, B.A.SC., M.B.E., F.C.A.S.I.

SPECIAL LECTURERS:

Special Lecturer in Engineering Law: W. O. C. Miller, B.A.SC.

PROFESSORS OF OTHER FACULTIES GIVING INSTRUCTION TO STUDENTS IN APPLIED SCIENCE

ASTRONOMY:

Associate Professor: P. R. Demarque, B.SC., M.A., PH.D.

BUSINESS ADMINISTRATION:

Professor: T. C. Graham, M.B.E., B.A.SC.

CHEMISTRY:

Professor: F. E. Beamish, M.A., D.SC.(MCM.).

Associate Professor: M. J. Dignam, B.A., PH.D.

Assistant Professors: R. G. Barradas, B.SC.(LIVERPOOL), PH.D.(OTT.); C. D. Cook, B.SC.(MANCH.), PH.D.

ENGLISH:

Professor: F. W. Watt, B.A., B.LITT., M.A., PH.D.

GEOLOGY:

Professors: J. B. Currie, B.A.(MCM.), M.A., PH.D.; W. W. Moorhouse, M.A., PH.D.(COL.), F.R.S.; E. W. Nuffield, B.A.(B.C.), PH.D., F.R.S.C.; F. G. Smith, M.SC.(MAN.), PH.D.

Associate Professors: F. W. Beales, M.A.(CANTAB), PH.D.; D. H. Gorman, B.SC.(N.B.), PH.D.; W. H. Gross, B.SC.(B.C.), M.A., PH.D.; R. R. H. Lemon, B.SC.(WALES), M.A., PH.D.; P. A. Peach, B.SC. (EDIN.), M.A., PH.D.; W. M. Tovell, M.S.(CAL.TECH.), PH.D.

Assistant Professors: E. J. Brooker, B.SC.(QUEEN'S), M.A.SC., PH.D.; J. C. Rucklidge, B.A.(CANTAB), PH.D.(MANCH.).

MATHEMATICS:

Professors: D. B. DeLury, M.A., PH.D.; G. F. D. Duff, M.A., PH.D., F.R.S.C.; W. J. Webber, B.A.(CANTAB), D.SC(WATERLOO).

Associate Professors: W. J. R. Crosby, M.A., PH.D.; W. H. Greub, M.A., PH.D.; R. Wormleighton, B.A., PH.D.(PRINC.).

Assistant Professors: M. A. Akcoglu, M.A., PH.D.; R. R. Burnside, A.R.C.S.T., PH.D.; P. B. Chapman, B.SC., B.E., PH.D.; N. A. Derzko, M.A., PH.D.; P. Greiner, M.A., PH.D.; D. R. Masson, M.A., PH.D.; D. K. Sen, M.SC., DR. ÈS SC.; S. H. Smith, M.A., PH.D.; J. R. Vanstone, M.A., PH.D.; M. Wonenburger, PH.D.(YALE), DR.MATH. (MADRID).

PHILOSOPHY:

Professor: M. Long, M.A., PH.D.

Assistant Professor: F. F. Wilson, PH.D.

PHYSICS:

Professors: E. J. Allin, M.A., PH.D.; A. W. Brewer, M.SC., PH.D.(LOND.); G. D. Garland, M.A., PH.D.(ST. LOUIS); R. List, DIPL.PHYS.ETH., DR.SI.NAT.(ZURICH); J. N. P. Hume, M.A., PH.D.; D. G. Ivey, M.A. (B.C.), PH.D.(NOTRE DAME); K. G. McNeill, M.A., D.PHIL.(OXON); A. D. Misener, M.A., PH.D.(CAMB.); J. C. Stryland, PH.D.(AMST.); L. E. H. Trainor, M.A.(SASK.), PH.D.(MINN.); J. Van Kranendonk, PH.D.(AMST.); H. L. Welsh, M.A., PH.D., D.SC., F.R.S.C., F.R.S.; J. T. Wilson, O.B.E., B.A., M.A.(CANTAB), PH.D.(PRINC.), F.R.S.C.

Associate Professors: R. M. Farquhar, M.A., PH.D.; F. S. Grant, B.A.SC., M.A.(ILL.), PH.D.; H. P. Gush, B.E., B.A., M.SC.(SASK.), PH.D.; J. W. Moffat, PH.D.(CAMB.); D. A. L. Paul, B.A.(CAMB.), PH.D. (QU.); R. Richmond, M.A., PH.D.; J. C. Savage, B.S.(ARIZ.), PH.D. (CAL.INST.TECH.).

Assistant Professors: R. L. Armstrong, M.A., PH.D.; M. Fowler, B.A., PH.D.(CAMB.); A. D. May, M.A., PH.D.; J. M. Perz, M.A.SC., PH.D. (CAMB.); J. D. Poll, PH.D.; R. E. Pugh, M.A.(B.C.), PH.D.(IOWA); G. F. West, B.A.SC., M.A., PH.D.; D. York, B.A., D.PHIL.(OXON.).

SECTION IV. HISTORICAL SKETCH

The Legislature Assembly of the Province of Ontario during the Session of 1877 gave its sanction to the establishment of a School of Practical Science on the basis proposed in the memorandum of the Minister of Education confirmed by the Lieutenant-Governor in Council on February 3, 1877.

By the scheme thus approved the Government effected an arrangement with the Council of University College whereby the instruction given by its professors and lecturers in all departments of science embraced in the work of the School was made available to students of the School. This arrangement was brought to an end in 1889 by the transfer of the departments of science, above referred to, from University College to the University of Toronto under the operation of the University Federation Act. In order that the students of the School might continue to enjoy the advantage of the instruction of the above departments, the Senate of the University of Toronto passed a statute in October, 1889, affiliating the School with the University. The statute was confirmed by the Lieutenant-Governor on October 30, 1889.

By an Order-in-Council, approved by the Lieutenant-Governor on the 6th day of November, 1889, a Principal was appointed, and the management of the School was entrusted to a council composed of the Principal as chairman, and the Professors, Lecturers, and Demonstrators appointed in the Teaching Faculty of the School.

On December 14, 1900, the Senate, by statute subsequently approved by the Lieutenant-Governor in Council, established a Faculty of Applied Science and Engineering but without assuming any liability for its support or maintenance. Under this statute the teaching staff and examiners of the School of Practical Science became the teaching staff and examiners of the Faculty, although the University retained the right to appoint the examiners for the Bachelor of Applied Science and professional degrees. By the University Act of 1906 the School of Practical Science became the Faculty of Applied Science and Engineering of the University of Toronto.

On April 8, 1892, the Senate of the University established the Degree of B.A.Sc., which was open to those who held the Diploma of the School and were prepared to devote a fourth year to advanced work. In the Session of 1909–1910 a new course extending over four years and leading to the Degree of B.A.Sc., came into operation, taking the place of the long established diploma course of three years, which came to an end in the Session 1910–1911. In the session 1923–24 the degree was changed to B.Arch. for the students graduating in Architecture. On July 1, 1948, the School of Architecture was separated from the Faculty and became an independent School with its own Director and Council.

With the end of the Second World War during the summer of 1945 the University was faced with the difficult problem of providing accom-

modation for almost double the number of students that had been registered in the previous year. Through the efforts of the Chairman of the Board of Governors and the President, the University leased from the Crown part of the large shell-filling plant at Ajax, twenty-five miles east of Toronto, to relieve the heavy demand for space at Queen's Park. Because it became evident, at an early stage, that a relatively large number of students would register in the Faculty of Applied Science and Engineering, it was decided that the work of the First and Second Years of this Faculty should be given at Ajax.

A special First Year session with approximately 1,400 students commenced at Ajax on January 14, 1946. In the regular 1946–47 session both First and Second Year instruction, except Second Year in Architecture, was given at Ajax with 1,800 registered in the First Year and 1,500 in the Second Year. In the 1947–48 session the enrolment at Ajax consisted of 1,200 students in the First Year and 1,400 in the Second Year. In the session 1948–49, 600 were registered at Ajax in the First Year and 975 in the Second Year. All other instruction was given in Toronto.

To provide for this self-contained University community at Ajax, there were 446 acres and 111 buildings. The University operated such services as central heating, road maintenance, water supply, sewage disposal, fire department, transportation, post office, laundry, private hospital, cafeteria, tuck shop and barber shop. Former production-line buildings were altered to accommodate 37 lecture rooms, 20 draughting rooms and 14 laboratories. In the 1946–47 session, 2,300 students were in residence, in 1947–48 there were 1,800 students and in 1948–49 there were 900. Student life at Ajax compared favourably with that in Toronto, excellent accommodation being provided for a general circulating library, a technical library, Hart House Ajax, the Athletic Association, the Health Service, Students' Administrative Council, Advisory Bureau for Ex-Service Students, and a small chapel.

Meanwhile, the erection of the Wallberg Building and an addition to the Mechanical Building was in progress, and with this additional accommodation becoming available on the Queen's Park campus, Ajax was closed on May 31, 1949.

The long-felt need for additional space for Civil Engineering and Electrical Engineering, and the projected expansion of the University as a whole to meet the expected demand for greatly enlarged enrollment, led to the construction of the Galbraith Building. Partially occupied during the 1960–61 session it was officially opened on March 7, 1961, by the Honourable J. Keiller Mackay, D.S.O., V.D., Q.C., LL.D., D.C.L., Lieutenant Governor of Ontario. The building houses Civil Engineering, Electrical Engineering, the Institute of Aerophysics, and the Faculty Office.

SECTION V. GENERAL INFORMATION, ADMISSION AND REGISTRATION

Inquiries about admission to this Faculty should be addressed to the Director of Admissions, Simcoe Hall, University of Toronto.

RESTRICTION OF REGISTRATION

The right is reserved to limit the number of students admitted to any course in the Faculty.

1. ADMISSION REQUIREMENTS

SESSION 1966–67

Candidates for admission to the courses leading to the degree of Bachelor of Applied Science must have standing in the following Grade 13 subjects, or their equivalent, with an overall average of 70% for Engineering Science and 64% for all other courses:
English; Algebra; Analytical Geometry; Trigonometry and Statics; Physics; Chemistry; and one of: French; German; Greek; Italian; Latin; Russian; Spanish.

Candidates applying for admission directly from High School must write the scholastic aptitude tests described in section 2 following.

SESSION 1967–68

ONTARIO GRADE 12 PRESCRIPTION: Ontario Grade 13 candidates must also have Grade 12 standing in at least *six* subjects (excluding Physical Education). The subjects chosen must include at least *five* of the following subjects and at least one subject from each of the four groups:

(i) English
(ii) French; German; Greek; Italian; Latin; Russian; Spanish
(iii) Geography (Parts 1 and 2); History (Parts 1 and 2)
(iv) Mathematics (Parts 1 and 2); Science (Physics and Chemistry).

Note: These requirements are effective for admission in September 1967. However, for admission to the 1967–68 Session and the 1968–69 Session, applications will be considered from candidates who find it impossible to meet the above requirements because of the programme taken in Grade 11 in 1964–65 and in 1965–66.

ONTARIO GRADE 13 REQUIREMENTS: Standing in the following subjects, with an overall average of 70% for Engineering Science and 64% for other courses:
Mathematics (Parts A and B); Physics; Chemistry; and an optional subject or subject comprising two credits, chosen from the following: English; French; German; Greek; Italian; Latin; Russian; Spanish; Biology; Geography; History; Music or Art. (A candidate may not offer both Music and Art.)

If a seven-credit programme is presented, at least five of the seven credits must have been obtained in 1967.

If the candidate wishes to use three or more credits obtained in 1966 or earlier he must present a total of nine credits.

Candidates applying for admission directly from High School must write the scholastic aptitude tests described in section 2 following.

2. SCHOLASTIC APTITUDE TESTS

All candidates applying for admission to the First Year directly from High School must take the aptitude test offered by the College Entrance Examination Board. This test consists of two parts—verbal and mathematical. It should be taken in December or January of the final year of school. United States candidates transferring from a First Year college programme in the United States and seeking admission to First Year programme at this University also must offer the College Entrance Examination Board aptitude test.

Students may obtain information about the test and test centres by inquiring at their school or by writing to the College Entrance Examination Board. Students in Ontario and other eastern parts of Canada and the United States should write to the CEEB at Box 592, Princeton, New Jersey 08540; students from the west should write to the CEEB, Box 1025, Berkeley, California 94701.

Under the University's admission practices, the school record of the applicant, the confidential report of the school and other tests of the student's ability that are available are considered. The length of time taken and number of sittings at examinations to obtain the admission requirements also are taken into account. Decision on those whose certificates meet the published requirements but whose academic record is not of a standard to permit immediate admission will be deferred, and their application will be considered for selection at a later date when all applications have been examined. A decision will be communicated to these applicants as early in August as possible.

3. EQUIVALENT CERTIFICATES

The following certificates are usually accepted as equivalent to Ontario Grade XIII although individual subjects cannot always be equated. Specific details on the standing required in particular cases will be supplied on request.

CANADA (Standing as outlined in (1) above is required on the following certificates from Canadian provinces):

Alberta, Manitoba, Nova Scotia, Saskatchewan—Grade 12.

British Columbia, New Brunswick—Senior Matriculation.

Newfoundland—First Year Memorial University.

Prince Edward Island—Third Year Certificate of Prince of Wales College.

Quebec—Senior High School Leaving Certificate; McGill Senior School Certificate; English Catholic Senior High School Leaving Certificate (5th Year High—Grade 12). Other certificates will be considered.

England, West Indies, East and West Africa:

(i) General Certificate of Education showing either

(a) Passes in five subjects of which at least two must be passed at advanced level; or

(b) Passes in four subjects of which at least three must be passed at advanced level.

In either case, passes are required in Physics, Chemistry, and an acceptable mathematical subject. At least two of these must be at advanced level.

or (ii) School and Higher School Certificates, which are equated to the General Certificate of Education as follows, and accepted on that basis:

Credits on the School Certificate are accepted as ordinary level passes on the General Certificate of Education; subsidiary passes on the Higher School Certificate as ordinary level passes on the General Certificate of Education; and principal or main subject passes on the Higher School Certificate as advanced level passes on the General Certificate of Education.

Hong Kong:

(i) General Certificate of Education or School and Higher School Certificates as stated above; or

(ii) University of Hong Kong Matriculation Certificate, accepted on the same basis as General Certificate of Education.

(iii) Hong Kong English School Certificate (1965) in conjunction with (i) or (ii).

Note: Hong Kong English School Certificates issued prior to 1965 are not acceptable for admission purposes.)

United States of America:

First Year University credits (a minimum of 30 semester hours) in the required subjects from accredited institutions of higher learning. A United States High School Graduation Diploma will not normally admit a candidate to any course. Advanced Placement work will, however, be considered.

Candidates seeking admission on the basis of certificates which are in a language other than English must submit photostatic copies of their certificates, rather than the original copies. Notarized English translations of the certificates must accompany the photostatic copies. When the certificates do not indicate the subjects studied and the grades secured in the individual subjects in the final year, candidates are required to submit certified statements from authorized officials of the institutions attended, or submit statutory declarations giving the required information.

4. ENGLISH FACILITY REQUIREMENTS

All applicants are required to submit evidence acceptable to the University of Toronto of facility in English. Candidates whose mother tongue is not English may be required to meet an appropriate standard in a recognized English facility test. The following evidence is acceptable:

(*a*) The University of Michigan English Language Test. This test is available at the University of Toronto for residents of the Toronto area.

Enquiries about writing the test in Toronto should be addressed to the Office of Admissions, Simcoe Hall, University of Toronto.

(*b*) The Certificate of Proficiency in English issued by the Universities of Cambridge or Michigan.

Information about writing the tests in (*a*) or (*b*) above in overseas centres may be obtained from the Office of Admissions, Simcoe Hall, University of Toronto.

The University is prepared to consider other evidence of English facility which may be submitted for evaluation to the Office of Admissions.

5. MATURE STUDENTS

(*a*) *Admission Regulations*

Candidates of mature age (30 years or older on October 1 of the session to which admission is sought) who have lived in Ontario for a minimum period of one year, and are normally resident in Ontario, may request special consideration if they have not completed in full the published Grade 13 (or equivalent) requirements. Such applicants must submit a birth certificate at the time of application.

(*b*) *Probationary Status*

Candidates accepted by the Senate's Committee on Admissions as mature students are admitted on probation.

Mature students, registered in full-time day courses, must obtain standing in their first year of full-time study in order to have their probationary status removed. If they do not obtain standing they will not be allowed to repeat the year or to enrol in any other degree or diploma course in the University until they present in full the published admission requirements.

6. APPLICATION PROCEDURES

Candidates seeking admission to undergraduate degree and diploma courses must submit the following to the Office of Admissions, Simcoe Hall:

(*a*) Completed application forms (incomplete forms will be returned and may delay decisions on admission).

(*b*) All Senior Matriculation Certificates held. These certificates must indicate the subjects studied and grades obtained. If a certificate is not available at the time of application, candidates must indicate the exact name of the certificate to be presented for admission, and the subjects included therein, as well as the approximate date available. A notarized English translation must accompany certificates which are in a language other than English.

(*c*) Candidates entering direct from high school—a confidential report to be sent direct from the School to the Office of Admissions. (The Office of Admissions will provide schools with these forms.)

(*d*) In addition to 1, 2, and 3, a student who has previously attended a University must submit the following whether the candidate has passed, failed or withdrawn:

(i) Official transcripts issued by the University or College previously attended, giving in detail the courses completed, with

the standing and grades in each. Transcripts or a supporting letter from the Registrar of the University or College must indicate that the candidate has been granted honourable dismissal and is eligible for selection to the institution concerned in the session for which he seeks admission to the University of Toronto; and

(ii) Official statements or calendars giving full information on the content of the University courses covered by the transcripts submitted.

Candidates who are not certain that they meet the published admission requirements should communicate with the Office of Admissions, giving full details regarding their academic standing, before submitting formal applications.

Application for Admission with Advanced Standing

A candidate seeking admission on an advanced standing basis must submit to the Office of Admissions, Simcoe Hall, prior to the dates mentioned above, his completed application form and the documents outlined in 5 (*b*) and (*d*).

7. TERMINAL DATES FOR SUBMISSION OF APPLICATIONS AND CERTIFICATES

Applications for admission to undergraduate degree courses should be submitted as early as possible in the year for which the candidate seeks admission.

(*a*) March 1, 1966—Applications to be considered for early admission (See Section 8).

(*b*) June 1, 1966—All other applications. Only in circumstances which the Committee on Admissions deems exceptional will a late application be considered.

8. EARLY ADMISSION ARRANGEMENTS (Ontario Applicants for First Year)

Ontario Grade 13 students wishing to avail themselves of the Early Admission procedures, which will provide by June to First Year applicants notification of Early Admission, must forward their applications by March 1st. They must also request their School Principals to submit the completed Confidential Report Form by that date. CEEB Test results must also have been received by March 30.

Only a limited number of the available student places in the University are offered under the Early Admission arrangements. All applicants who pass the Ontario Grade 13 examinations with the published admission requirements are eligible for selection to the University.

9. ADMISSION REGULATIONS CONCERNING CANDIDATES WHO HAVE PREVIOUSLY FAILED IN UNIVERSITY WORK

(*a*) A candidate who, on one occasion has failed to secure the right to advance to a higher year at the University of Toronto or at any other institution of higher learning, may be eligible for selection to the University of Toronto subject to warning of probable required withdrawal from his Faculty and possible debarment from the University on a second failure.

(*b*) A student who on two occasions has failed to secure the right to advance to a higher year at the University of Toronto will normally be refused readmission to his faculty and may be debarred from registration in any division of the University of Toronto. Candidates with two such failures at other institutions will normally be refused admission.

10. PROCEDURE FOR REGISTRATION

Detailed instructions concerning Registration and Health Requirements will be mailed to returning and newly admitted students before the beginning of each academic year.

11. HEALTH REQUIREMENTS

Every person admitted to the University as an undergraduate must, at the time of his or her first medical examination by the University Health Service, present satisfactory evidence of successful vaccination within three years prior to the date of the examination, or must be vaccinated by the examining physician.

12. PROCEDURES FOR WITHDRAWALS OR TRANSFERS

A student who wishes to withdraw or to transfer his course or division in the University should consult his College Registrar or Faculty/School Secretary.

COLLEGES

With the establishment of New College and Innis College, which are open to students of all faculties, it is now possible for students of the Faculty of Applied Science and Engineering to become members of a college. Membership in a college is not obligatory, and application for membership is at the option of the student.

Students entering the First Year who are interested in becoming members of either college should indicate their choice in the space provided on the University's admission application form. A college fee of $15 is required upon acceptance.

The facilities of Innis College and New College are described below.

INNIS COLLEGE

Innis College was constituted on July 1, 1964, and admitted its first students in the following September. It is a multi-faculty college of the University of Toronto, and includes undergraduate students in all Faculties and Schools of the University. In the academic session 1965–66, only First and Second Year students may apply for membership in the College.

A special feature is the Writing Laboratory. This service offers assistance to Innis College students in the skills and methods of writing essays and other academic reports. A staff of experienced teachers is available tc give individual instruction.

NEW COLLEGE

New College is a multi-faculty co-educational college; in addition to students from the Faculty of Arts and Science those from other Faculties and Schools are eligible for membership. This gives students from all divisions of the University the opportunity to participate in the life of a college and to associate with students in other fields of study. Tutorial classes are provided for First Year students in some subjects.

The new building, centrally located on the west campus, provides academic, social and dining facilities for all members of the College and in addition accommodates nearly 300 male students in residence.
Students applying for membership in the College who wish accommodation in the Residence must apply on the prescribed form which may be obtained from the Dean of Students, New College.

RESIDENCE ACCOMMODATION

DEVONSHIRE HOUSE

Devonshire House, the University Residence for Men, accepts students from all Faculties. The facilities of the residence include a library, music listening room, music practice room, common rooms, kitchenettes, laundry room, television and games rooms. It does not have a dining hall. Members may take their meals at Hart House, Howard Ferguson Hall, or New College, all located nearby.
Application forms may be obtained from the Secretary to the Dean, Devonshire House, University of Toronto. Application should be made as early as possible.

NEW COLLEGE

The residence facilities of New College, and the procedure for application, are described in the entry under Colleges, above.

Each of the four Arts Colleges also maintains a Men's Residence, into which some engineering students may be accepted. Further information may be obtained from

University College—Dean of Men
Victoria College—Senior Tutor
Trinity College—Registrar, Trinity College
St. Michael's College—Dean of Residence

HOUSING SERVICE

For the convenience of those students who are not able to find accommodation in the University and College residences, the University maintains a listing of rooming houses, flats, apartments and homes. Information on these rooms may be obtained through the Housing Service office at 581 Spadina Avenue, Toronto 4.

Off-campus housing of this nature is not subject to University regulation. However every effort is taken to make the information on the accommodation as complete as possible and students are encouraged to assist in this effort by reporting on the quality of the accommodation that they have occupied.

CAMPUS CO-OPERATIVE RESIDENCE

The Campus Co-operative Residence, Inc. offers certain housing accommodations for undergraduate and graduate students. Since the University of Toronto has no official connection with the Campus Co-operative Residence, Inc., inquiries about accommodation available through that organization should be addressed directly to:

Campus Co-operative Residence, Inc.,
395 Huron Street,
Toronto 5, Ontario.

SECTION VI. FEES, DEPOSITS AND EXPENSES

FEES

1. A student who desires to enrol in the Faculty of Applied Science and Engineering is required to pay at least the First Term Instalment of fees on or before the opening date of the session, and before he can receive his admit-to-lectures card from the Secretary of the Faculty. The amount of the First Term Instalment of fees or of the Total Fee for the session may be ascertained from the schedule of fees below.

2. The Second Term Instalment of fees, if not already paid, is due on the opening day of the second term and must be paid not later than January 15. After this date an additional fee of $3 per month or portion thereof (not exceeding $10), will be imposed until the whole amount is paid. All fees for the session must have been paid in full before the student can be admitted to the annual examinations.

3. Students will receive by mail in August a fees form and instructions for the payment of fees. In order to avoid delay in registration at the opening of the session it is recommended that at least the first term instalment of fees be forwarded by mail as early as possible in September.

4. The Chief Accountant will receive fees in Cody Hall, School of Nursing from 9 a.m. to 5 p.m. Monday to Friday, August 8 to September 16, and on Saturday morning, September 17, from 9 a.m. to 12 noon. Following this date, payment of fees will be made at the Office of the Chief Accountant, 215 Huron St. Cheques in payment of fees should be made payable to the University of Toronto at par in Toronto.

5. Each undergraduate enrolled in the Faculty of Applied Science and Engineering must pay annual fees to the Chief Accountant according to the schedule below; the total fee in each case is made up of the academic fee and incidental fees; all incidental fees are payable in the first term.

Schedule of Fees

Men

Academic Year	*Academic Fee	†Incidental Fees	Total Fee (if paid in one instalment)	First Term Instalment	Second Term Instalment
I-IV	$650	$63	$713	$388	$328

Women

I-IV	$650	$35	$685	$360	$328

*The Academic Fee includes the following fees:
Tuition; Library and Laboratory Supply; one Annual Examination; Laboratory Fee; Physical Education; and Degree.

†These Incidental Fees include the following fees:
For men—Hart House; Students' Administrative Council; Athletic; Health Service; Engineering Society; Faculty Athletic Association.
For women—Students' Administrative Council; Athletic; Health Service; Engineering Society.

LATE REGISTRATION FEE

6. Any student who registers after the last date for normal registration in his or her own faculty or school is required to pay a late registration fee of $10 plus $1 for each day of delay to a maximum of $20.

OTHER UNIVERSITY FEES

7. Each student is required to pay to the Chief Accountant at the opening of the session, or as otherwise specified, such of the following fees as may be required of him.

EQUIVALENT CERTIFICATE FEE

8. Each student who has been admitted to the First Year upon a certificate or certificates granted outside the Province of Ontario and covering all or any part of the admission requirements, must pay a fee of $5.

ADVANCED STANDING FEE

9. Each student who has been admitted to advanced standing from another university or college, must pay a fee of $10.

SPECIAL STUDENTS FEES

10. The fee is $95 per subject, payable to the Chief Accountant.

SUMMARY OF STUDENTS' EXPENSES

11. The following approximate statement of expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering in the University of Toronto, exclusive of personal expenses:

1. Fees, see schedule page 23.
2. Board and Lodging, per week .....$20 up
3. Books and instruments, per year .....about $100

CHILDREN OF WAR DEAD (EDUCATION ASSISTANCE) ACT

Children of War Dead (Education Assistance) Act provides fees and monthly allowances for children of veterans whose death was attributable to military service. Enquiries should be directed to the nearest District Office of the Department of Veterans Affairs.

SECTION VII. COURSES AND DEGREES

THE UNDERGRADUATE PROGRAMME

The Faculty offers the following courses leading to the degree of Bachelor of Applied Science:

Civil Engineering (Course 1)
Mechanical Engineering (Course 3)
Industrial Engineering (Course 4)
Engineering Science (Course 5)
Chemical Engineering (Course 6)
Electrical Engineering (Course 7)
Metallurgy and Materials Science (Course 8)
Geological Engineering (Course 9)
Aerospace Engineering (offered as an option in Engineering Science. See page 59).

The courses extend over four academic sessions. Full time attendance during the academic session is required; the Faculty does not offer part-time or evening courses leading to the degree.

The curricula of the various courses are set out in detail in Section VIII.

The requirements respecting examinations and promotion and the general regulations concerning students in attendance are shown in Section IX.

GRADUATE STUDY AND RESEARCH

Facilities are available in the Departments of the Faculty for post-graduate study and research leading to the degrees of Master of Engineering (M.Eng.), Master of Applied Science (M.A.Sc.), and Doctor of Philosophy (Ph.D.). For further information see the Calendar of the School of Graduate Studies.

DIPLOMA COURSE IN OPERATIONS RESEARCH

A one-year diploma course in Operations Research is offered for those who have obtained a bachelor's degree in engineering, science, or mathematics. The diploma course is designed specifically to meet the needs of people who are presently employed in industry and who aspire to develop special skills in the design, analysis, and control of complex organizational systems.

Inquiries regarding the Diploma Course in Operations Research should be directed to the Secretary, Faculty of Applied Science and Engineering.

SPECIAL STUDENTS

Graduates of the University of Toronto and of recognized universities who wish to take one or more undergraduate subjects may be registered

as special students in the Faculty of Applied Science and Engineering, subject to the approval of the teaching department concerned. Application must be made to the Secretary of the Faculty.

INTERIM HIGH SCHOOL ASSISTANT'S CERTIFICATE TYPE A

Graduation in Engineering Science is accepted by the Ontario College of Education as meeting the academic requirements for admission to the course leading to a Type A certificate in Mathematics and Physics.

Graduates in other engineering courses may also be admitted to Type A Certificate courses at the Ontario College of Education if they submit official transcripts which indicate that they have sufficient academic credits.

Graduates in engineering courses who lack sufficient academic credits for admission to Type A courses at the Ontario College of Education may be eligible for admission to the Type B course and later for endorsement of the Type B Certificate in Mathematics and Physics.

Inquiries regarding endorsement of Type B Certificates or admission to Type A Certificate courses should be directed to the Director, Advanced Academic Recommendations, Ontario College of Education.

ASSOCIATIONS OF PROFESSIONAL ENGINEERS

Graduation from the Faculty of Applied Science and Engineering leads to registration as a Professional Engineer in the various Associations of Professional Engineers throughout Canada.

SECTION VIII. CURRICULUM

The courses are designed to give the student a thorough grounding in the fundamentals of engineering, with emphasis on their practical application in the field in which he has chosen to study. In the First Year there is little differentiation between the various courses with the exception of Engineering Science. In the succeeding years, specialization develops to a considerable extent, with provision in the Third and Fourth Years for optional subjects in some of the courses.

The Faculty has excellent laboratory facilities, in which the students do practical experiments and problems related to the lecture subjects. In some graduating courses, laboratory work in the Fourth Year consists of the investigation of some specific problem. In all instances, the student's knowledge of the original literature and primary sources of information is extended, and he is given a very desirable and useful training in methods of research. As part of the laboratory instruction, excursions to places of technical interest are arranged by the staff. These excursions are treated as laboratory periods, with the same requirements as to attendance and reports.

As in the case with other professions, the engineer should be prepared to assume positions of professional and community leadership. Accordingly, the curriculum contains a basic core of humanistic-social studies, including English, Political Science, Economics, Modern History, and Philosophy of Science. It is hoped that this introduction to the humanities will stimulate the student to do further reading and study, thereby increasing his professional effectiveness.

On the following pages of this section, the curriculum for each course is set forth in detail. The time devoted to lectures and practical work is indicated as accurately as possible, but is subject to modification as occasion may require. The programme and regulations regarding the courses of study and examination, contained in this Calendar, hold good for this academic year only, and the Faculty of Applied Science and Engineering does not bind itself to adhere for the whole period of a student's course to the conditions here laid down.

Communications relating to curricula, instruction, and examinations in the Faculty of Applied Science and Engineering should be sent to the Secretary of the Faculty.

For information regarding the courses of study leading to the postgraduate degrees, Master of Engineering, Master of Applied Science, and Doctor of Philosophy, see the calendar of the School of Graduate Studies, which gives full particulars.

FIRST YEAR CURRICULUM

The courses in Civil Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering, Metallurgy and Materials Science, and Geological Engineering are designated as Division A and have a common First Year. The First Year curriculum in Engineering Science is designated as Division B.

A student, on petition to the Faculty Council, may be permitted to change his course at the end of the First Year.

FIRST YEAR CURRICULUM

Division A

Civil Engineering
Mechanical Engineering
Industrial Engineering
Chemical Engineering
Electrical Engineering
Metallurgy and Materials Science
Geological Engineering

First Year Subjects Division A	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	600,601	2	3	2	3
Engineering Problems and Drawing	137	–	6	–	6
English	2110	2	–	2	–
Mathematics:					
Algebra and Analytic Geometry	2410	2	1½	2	1½
Calculus	2411	2	1½	2	1½
Descriptive Geometry	135	1	–	1	–
Physics:					
Electricity	700, 2502	2	3	2	3
Mechanics	100, 2502	2		2	
Structure and Properties of Matter	2501, 2502	2		2	
Practical Experience	10	–	–	–	–

DIVISION B
Engineering Science

FIRST YEAR SUBJECTS DIVISION B	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	602, 601	2	3	2	3
Engineering Problems and Drawing	142	–	3	–	3
English	2110	2	–	2	–
Mathematics:					
Algebra and Geometry	2415	2	3	2	3
Calculus	2416	2		2	
Descriptive Geometry	135	1	–	1	–
Physics:					
Electricity	701	2	–	2	–
Statics	101	2	–	–	–
Properties of Matter; Mechanics and Heat	2511, 2512	3	4	3	4

CIVIL ENGINEERING

(Course 1)

The course in Civil Engineering has been so designed as to be broad and comprehensive. It has been designed not only to meet the needs of those who have definitely decided to enter this branch of the profession, but also of those who desire an engineering education of such a basic character as to enable them to enter various other fields of engineering employment.

In addition to instruction in engineering subjects, sufficient time is assigned to economic, legal and administrative studies to qualify the graduate in this course not only to engage in any of the branches of Civil Engineering but also to do administrative or executive work in industrial, commercial, government or other undertakings of an engineering character.

In the final year four options are offered:

A—Structural
B—Surveying
C—Municipal and Sanitary
D—Transportation and Soil Mechanics

Because of the common core of Civil Engineering material in the course, a graduate in any option will not be at a serious disadvantage when engaged in engineering work that is more closely associated with one of the other options.

Most of the subjects in the Third Year are taken by all students, but, in addition to these common subjects, students proceeding to options A, C, and D in the Fourth Year must take the Group A subjects while those proceeding to option B must take the Group B subjects.

The subjects of instruction are shown in the following tables. In these tables numbers have been assigned to the subjects which refer to a more detailed description of each, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Alternating-Current Circuits	717, 718	2	1½	–	–
Calculus	2420	2	–	2	–
Dynamics	350	–	–	2	–
Economics	2720	2	–	2	–
Engineering Chemistry	607	2	–	–	–
Engineering Geology	2900	2	–	1	3
Engineering Thermodynamics	302	–	–	2	–
Engineering Problems and Drawing	138	–	6	–	6
Mechanics of Materials	105, 104	2	–	2	3
Physical Metallurgy	815	–	–	2	–
Physics—Heat and Optics	2525	2	1½	—	—
Practical Astronomy	157	–	–	2	–
Practical Experience	10	–	–	–	–
Surveying	153, 154	2	3	1	3

Each student in Civil Engineering is required to state, not later than June 30 following the completion of his Second Year, the group of subjects he desires to pursue in the Third Year. Permission to take either group of subjects must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Third Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Fluid Mechanics	333, 334	2	–	2	3
Highway Engineering I	185, 195	2	1½	–	–
Engineering Mathematics	141, 139	2	1½	2	3
Municipal Planning, Administration and Transportation	186	–	–	3	–
Practical Experience	10	–	–	–	–
Sanitary Engineering	180	2	–	–	–
Soil Mechanics	191, 195	2	1½	–	–
Survey Camp	158	–	–	–	–
One of					
Modern World History	2330	2	–	2	–
Political Science	2730				
And either of the following groups of subjects:					
Group A (Leading to options 1A, 1C and 1D)					
Mechanics of Materials II	110, 113	2	7½	2	6
Structural Design I	111, 113	2		2	
Structural Theory I	112, 113	–		3	
Group B (Leading to option 1B)					
Geodetic Engineering	160, 161	–	–	2	3
Least Squares	159	–	3	–	–
Photogrammetry I	162, 163	2	3	–	–
Photo Interpretation	164, 165	–	–	2	3
Structural Engineering I	114, 115	2	1½	2	3

Civil Engineering students selecting the Group A subjects are required to state not later than June 30 following the completion of their Third Year the options (one of options 1A, 1C or 1D) they desire to pursue in the Fourth Year. Permission to enter upon an option must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Civil Engineering students selecting the Group B subjects in their Third Year must pursue option 1B in their Fourth Year.

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Construction Management and Business	130	–	–	2	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
And one of the following options:					
OPTION 1A (Structural)					
Behaviour and Design of Steel Structures	118	2	–	2	–
Hydraulic Engineering	343	–	–	2	3
Mathematical Applications	140	2	–	–	–
Reinforced Concrete I	116	2	–	2	–
Reinforced Concrete II	117	2	–	2	–
Soil Mechanics and Foundations	192, 196	2	–	1	2
Structural Theory II	119	2	–	3	–
Thesis Project, Laboratory and Seminar	20, 120	–	12	–	10
OPTION 1B (Surveying)					
Geodetic Adjustments	168, 169	1	3	1	3
Photogrammetry II	170, 171	1	3	1	1½
Astronomy	172, 173	1	3	–	–
Engineering and Legal Surveys	174	2	–	1	–
Geodesy and Electronic Surveying	175, 176	2	1½	2	3
Hydraulic Engineering	343	–	–	2	3
Structural Engineering II	122, 123	2	4½	2	3
Survey Camp	167	–	–	–	–
Town and Regional Planning	3540, 3541	1	3	1	3
Thesis	20	–	–	–	1

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 1c (Municipal and Sanitary)					
Air and Water Resources	181	2	–	3	–
Traffic Engineering	187	–	–	2	–
Hydraulic Engineering	341, 342	2	1½	2	3
Mathematical Applications	140	2	–	–	–
Municipal Engineering and Planning; Sanitary Chemistry	182	2	–	2	–
Reinforced Concrete I	116, 121	2	3	2	3
Soil Mechanics and Foundations	192, 196	2	–	1	2
Thesis Project, Laboratory and Seminar	20, 183	–	7½	–	7
Option 1d (Transportation and Soil Mechanics)					
Air Photo Interpretation	189, 197	1	3	–	–
Traffic Engineering	187	2	–	–	–
Hydraulic Engineering	343	–	–	2	3
Mathematical Applications	140	2	–	–	–
Pleistocene Geology	2949	2	–	2	–
Reinforced Concrete I	116, 121	2	3	2	3
Soil Mechanics and Foundations	192, 196	2	2	1	–
Transportation Engineering	188	1	–	2	–
Earth Structures and Foundations	193	1	–	2	–
Thesis Project, Laboratory and Seminar	20, 198	–	4	–	9

MINING ENGINEERING

(Course 2)

The Mining Engineer is concerned with all aspects of the winning of metals and minerals from their geological environments in the earth's crust, and of their conversion to forms in which they can best be utilized in the growing needs and comforts of man. Thus, the course in Mining Engineering has been devised to prepare its graduates for successful participation in the engineering, operational, and administrative activities of those aspects.

The Mining Engineer has been traditionally concerned with the fields of mineral exploration, evaluation and development of mineral properties, the mining and treatment of ores, and the economics of mineral markets. Owing to the gradually changing aspect of engineering education at the undergraduate level, it has become desirable to transfer the work associated with these fields to the post-graduate level, and thus the undergraduate course in Mining Engineering will be progressively discontinued. Instruction in the Fourth Year only will be offered in the Session 1966–67. Graduate study and research, in collaboration with other Departments in the Faculty, will be encouraged.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 117.

Fourth Year Subjects Course 2	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
English	2140	1	–	1	–
Glacial Geology and Ground Water	2903	1	–	1	–
Machine Design	371, 372	1	–	1	3
Metallurgy	808, 809	1	–	1	3
Mine Operation and Administration	224, 225	2	2	2	6
Mineral Deposits	2940, 2941	2	–	2	3
Mine Ventilation	321, 251	2	3	–	–
Ore Dressing	244, 245	1	6	1	–
Physical Metallurgy	815	–	–	2	–
Practical Experience	10	–	–	–	–
Precambrian Geology	2944, 2945	2	1	–	–
Philosophy of Science	2040	2	–	–	–
Thesis Project, Laboratory, and Seminar	20, 275	–	$5\frac{1}{2}$	–	6

MECHANICAL ENGINEERING

(Course 3)

Traditionally associated with the art and science of power generation and the machines and devices by which power is usefully applied and controlled, Mechanical Engineering, like other branches of the engineering profession, participates actively in the advancement of knowledge and interprets this knowledge in the design and development of practical systems.

In manufacturing industry, in the transportation and power utilities, in the high-performance field of air and space engineering, or in engineering aspects of major works and structures, the mechanical engineer finds professional occupation, either as employee or consultant. His responsibility will generally be for the superintendence of operations and personnel, for the design of products and processes, and may include the administration of enterprises.

The curriculum in Mechanical Engineering provides an analytical training in mathematics and the physical sciences designed as a disciplinary basis for active professional practice. Recognition is given, however, to the purer scientific and philosophical concepts essential to postgraduate study and research.

The subjects of instruction are shown in the following tables, in which the assigned Subject Numbers refer to the more detailed descriptions given later, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Alternating-Current Circuits	717, 718	–	–	2	1½
Calculus	2420	2	–	2	–
Dynamics of Machines	357	3	–	3	–
Economics	2720	2	–	2	–
Electricity	714, 713	2	3	–	–
Engineering Chemistry	607	2	–	–	–
Heat Engineering, Elementary	303	–	–	2	–
Design of Machine Elements	356	–	–	2	–
Mathematical Analysis	383	–	1½	–	1½
Manufacturing Processes	355	1	–	–	–
Mechanical Design	358	–	6	–	6
Mechanics of Materials I	107, 104	3	–	1	3
Physical Metallurgy	817, 818	2	–	2	1½
Practical Experience	10	–	–	–	–

THIRD YEAR SUBJECTS COURSE 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Equations	2432	2	–	2	–
Electronics	743, 744	2	1½	–	–
Electric Machines	747, 748	2	1½	2	3
Engineering Analysis	386	–	1½	–	3
Engineering Thermodynamics	309, 310	2	3	2	3
Fluid Mechanics	333, 334	2	–	2	3
Heat Engineering	308	2	–	1	–
Machine Design	363, 364	2	6	–	3
Practical Experience	10	–	–	–	–
Treatment of Technical Data	387	–	–	2	3
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

FOURTH YEAR SUBJECTS COURSE 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Engineering	390	1	3	2	3
Elementary Control Theory	391, 392	1	–	1	3
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Heat Engineering Laboratory	324	–	3	–	4½
Hydraulics	344, 345	2	3	2	4½
Industrial Management	396	1	–	–	–
Machine Design	373, 374	2	3	2	4½
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Structural Engineering	126, 127	2	3	–	–
Thermal Energy Conversion I	322	2	–	2	–
Thermal Energy Conversion II	323	–	–	2	–
Thesis	20	–	1	–	1

INDUSTRIAL ENGINEERING

(Course 4)

The modern view of Industrial Engineering is that of a field concerned essentially with the analysis, design, improvement and operation of integrated systems of men, materials and equipment. This new concept crystallized when it became clear that certain modern technical fields, including operations research, control theory, computer science, and probability and statistics, constituted a body of knowledge particularly useful in the operation and management of modern business, industry and government.

As a logical outcome of this development, the course in Industrial Engineering was established in 1958 to provide graduates in engineering specializing in the theory and practice of these subjects. This specialization rests upon a substantial foundation in science and mathematics, in fundamental engineering disciplines including fluid mechanics, applied thermodynamics, electrical science, mechanics of materials and machine design, and in such subjects as economics, organizational structure, financial control and industrial psychology.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Calculus	2420	2	—	2	—
Computer Programming I	3333	1	1½	1	1½
Economics	2720	2	—	2	—
Electrical Engineering	719, 720	2	3	2	3
Elements of Industrial Engineering	414	2	—	2	—
Materials Science	834	2	—	2	3
Mathematical Analysis	383	—	1½	—	1½
Mechanics of Materials	102, 104	2	3	2	—
Probability and Statistics I	2423, 2424	2	2	2	2

THIRD YEAR SUBJECTS COURSE 4 (*Session 1966–67 only*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Accounting	2734	2	–	2	–
Computer Programming I	3333	1	1½	1	1½
Differential Equations	2432	2	–	2	–
Electronics	743, 744	2	1½	–	–
Fluid Mechanics	337, 338	2	3	–	–
Engineering Thermodynamics	311, 312	–	–	2	3
Industrial Management	3030, 3031	1	3	1	3
Numerical Analysis	2433, 2434	2	3	2	3
Probability and Statistics	2430, 2431	1	1½	1	1½
Practical Experience	10	–	–	–	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–

THIRD YEAR SUBJECTS COURSE 4 (*1967–68 and subsequently*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Accounting	2734	2	—	—	—
Computer Programming II	3335	1	1½	1	1½
Differential Equations	2432	2	1½	2	1½
Dynamics of Machines	361, 362	2	3	2	3
Engineering Thermodynamics	311, 312	—	—	2	3
Fluid Mechanics	337, 338	2	3	—	—
Human Factors Engineering I	415	—	—	2	—
Numerical Analysis	2433, 2434	2	1½	2	1½
Probability and Statistics II	2430, 2431	1	1½	1	1½
Practical Experience	10	—	—	—	—
and one of					
Modern World History Political Science	2330 2730	2	—	2	—

Fourth Year Subjects Course 4 (*1966–67 and 1967–68 only*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Current Developments in Industrial Engineering	409, 410	–	–	2	2
Dynamics of Industrial Systems	405, 406	2	3	–	–
Elementary Control Theory	407, 408	2	3	2	3
Electric Machines	760, 761	2	3	–	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Industrial Engineering Seminar	411	–	2	–	–
Industrial Psychology	2840	–	–	2	–
Machine Design	375, 376	2	3	2	3
Operations Research I	401, 402	2	3	2	3
Operations Research II	403, 404	–	–	2	3
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Thesis	20	–	2	–	2

Fourth Year Subjects Course 4 (*1968–69 and subsequently*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Elementary Control Theory	391, 392	1	—	1	3
Engineering Law	3440	1	—	—	—
English	2140	1	—	1	—
Human Factors Engineering II	416	2	—	2	—
Industrial Engineering Seminar	417	—	2	—	2
Management Science	418	2	—	2	—
Operations Research	419	2	3	4	3
Philosophy of Science	2040	2	—	—	—
Systems Theories	420	2	3	2	3
Thesis Project	421	—	6	—	6

ENGINEERING SCIENCE

(Course 5)

The Course in "Engineering Physics" was established in 1934 "to afford a training in mathematics and physics beyond that which it is possible to give in the other undergraduate courses in engineering". Originally the options offered in the Third and Fourth Years were related to the physical sciences and the name of the course, Engineering Physics, was appropriate.

In 1958 a Chemical Option was added on the same basis, i.e. in Third and Fourth Years.

In the session 1962–63 the scope of the course was broadened to include, more adequately than in the past, options related to the chemical sciences. The name of the course therefore was changed to "Engineering Science" commencing with the class graduating in 1965.

The purpose of the course is not changed. It is designed for those, who, having a definite flair for mathematics and science, anticipate proceeding to post-graduate study and an occupation in the fields research and development or teaching.

The options offered in the Third and Fourth Years cater to a variety of specific interests and prepare the student for post-graduate work in many of the Engineering Departments or in Physics, Biophysics or Applied Mathematics.

Admission to this course is granted only to those students who, having met the general admission requirements set forth on page 16 of this Calendar, obtain an average of 70% on the nine specified papers of Grade 13, or the equivalent in other school systems.

Promotion to the Second Year of the Engineering Science course is granted only to those students who, in addition to meeting the regular requirements, obtain a weighted average of not less than 66% on the examinations of the First Year. Students who obtain a weighted average of 60% or over in the First Year of this course, and who have met all the regular requirements, will be permitted to proceed to the Second Year of any course in the Faculty, other than Engineering Science, without condition. Permission to repeat the First Year of the course in Engineering Science must be sought by petition to the Council of the Faculty.

The subjects of instruction are shown in the following tables and are more fully described according to subject reference numbers, page 59 to 121.

For FIRST YEAR CURRICULUM—DIVISION B, see page 29.

Second Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Calculus	2425	2	–	2	–
Economics	2720	2	–	2	–
Electric Circuits	715, 716	2	1½	2	1½
Integral Calculus	2426	2	–	2	–
Mathematical Problems and Machine Computation	2428	–	3	–	3
Mechanics of Materials	103	1	–	1	–
Numerical Methods	2429	1	–	1	3
Physical Chemistry	608, 609	2	1½	2	1½
Physics	2521, 2522	3	3	3	3
Probability and Statistics	2427	2	–	2	–

Students are required to state at the beginning of the Third Year which option they intend to pursue. Council retains the right to withhold an option if the number of students offering or conditions existing at the time render it impracticable to give the work.

Third Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Mechanics of Structures	1034, 1035	2	1½	2	3
Fluid Mechanics	1028, 1029	2	3	1	1½
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

THIRD YEAR SUBJECTS COURSE 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5c, Chemical					
Atomic and Molecular Structure	2631	2	–	2	–
Chem. Eng. Rate Processes	641	2	–	2	–
Chem. Eng. Thermodynamics	640	2	–	2	–
Chem. Eng. Problems and Lab.	642	–	9	–	7½
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Fluid Mechanics	339, 340	2	3	2	3
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History / Political Science	2330 / 2730	2	–	2	–
Option 5e, Electrical					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Circuit Analysis	742	2	–	2	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Physics of Metals	819	–	–	2	–
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	2	–	–	–
Statistical Physics	2531	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History / Political Science	2330 / 2730	2	–	2	–
Option 5g, Geophysics					
Advanced Mechanics	1030	2	–	2	–
Astronomy and Geophysics	2537	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Physics Laboratory	2532	–	6	–	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History / Political Science	2330 / 2730	2	–	2	–

THIRD YEAR SUBJECTS COURSE 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5m, Materials Science					
Advanced Mechanics	1030	2	–	2	–
Atomic and Molecular Structure	2631	2	–	2	–
Chemistry of Metals	802, 829	2	–	–	3
Differential Equations	2438	2	–	2	–
Metallurgical Thermodynamics	830, 831	1	2	1	2
Materials Science	832	2	–	2	–
Physics of Metals	821, 822	2	6	2	3
Physics of Solids and Fluids	2534	1	–	1	–
Theory of Functions	2437	2	–	2	–
X-ray Crystallography	2901	–	2	–	2
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5nt, Nuclear and Thermal Power					
Advanced Mechanics	1030	2	–	2	–
Applied Elasticity	365, 366	1	3	1	3
Atomic and Nuclear Physics	2535	2	–	2	–
Differential Equations	2438	2	–	2	–
Fluid Mechanics	339, 340	2	3	2	3
Heat Engineering	313, 314	1	3	1	3
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–
Option 5p, Physics					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Crystallography	2902	1	–	1	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531		–	2	–
Theory of Functions	2437	2	–	2	–
One of:					
Applied Elasticity	365, 366	1	3	1	3
Circuit Analysis	742	2	–	2	–
And one of:					
Modern World History Political Science	2330 2730	2	–	2	–

Fourth Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Aerodynamics	1040, 1041	2	1½	2	1½
Differential Equations of Mathematical Physics	2445	2	—	2	—
Electronic Circuits	778, 769	3	3	—	—
Engineering Design	1043	—	4½	—	4½
English	2140	1	—	1	—
Gasdynamics	1048, 1049	1	1½	2	3
Philosophy of Science	2040	2	—	—	—
Plasmadynamics	1046	2	—	2	—
Thesis	20	—	—	—	—
Transport Phenomena	1050	1	—	1	—
and either (A) or (B) below:					
(A) Physics and Mechanics of Solids	1044, 1045	2	3	2	3
(B) Electromagnetic Radiation and Matter	2541	2	—	2	—
Plasma Diagnostics	1047	—	3	—	3
Option 5c, Chemical					
Chem. Eng. Design	666	2	6	2	6
Chem. Eng. Laboratory	652	—	9	—	—
Thermodynamics of Chemical Systems	665	3	—	—	—
Dynamics of Chemical Systems	667	—	—	3	—
English	2140	1	—	1	—
Instrumental Methods	663	—	—	2	—
Mass Transfer	650	2	—	2	—
Organic Chemistry	660, 661	2	—	1	6
Philosophy of Science	2040	2	—	—	—
Physics of Metals	816	1	—	1	—
Process Dynamics	664	2	—	2	3
Thesis	20	—	—	—	—
Option 5e, Electrical					
Differential Equations of Mathematical Physics	2445	2	—	2	—
Energy Conversion Processes	745, 746	2	1½	2	1½
Electronic Circuits	778, 769	3	3	—	—
English	2140	1	—	1	—
Information Systems	782, 783	2	—	3	3
Philosophy of Science	2040	2	—	—	—
Quantum Mechanics	2545	2	—	2	—

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
System Dynamics	766, 767	2	1½	2	1½
Wave Theory	790, 791	2	—	3	3
Thesis	20	—	—	—	—
Option 5g, Geophysics (Session 1966–67 only)					
Atmospheric Physics	2571	2	—	2	—
Atomic Structure and Quantum Physics	2533	2	—	2	—
Differential Equations of Mathematical Physics	2445	2	—	2	—
English	2140	1	—	1	—
Geophysical Methods	2561, 2562	2	7½	2	7½
Philosophy of Science	2040	2	—	—	—
Precambrian Geology	2944, 2945	2	1	—	—
Solids within the Earth	2572	1	—	3	—
Structural Geology	2932	1	3	1	3
Wave Theory	790	2	—	3	—
Thesis	20	—	—	—	—
Option 5g, Geophysics (commencing in 1967–68)					
Atmospheric Physics	2571	2	—	2	—
Differential Equations of Mathematical Physics	2445	2	—	2	—
English	2140	1	—	1	—
Geophysics Laboratory	2573	—	6	—	9
Geophysical Methods	2561	2	—	2	—
Philosophy of Science	2040	2	—	—	—
Physics of the Earth	2570	2	—	2	—
Principles of Geology	2920	2	3	2	3
Solids within the Earth	2572	2	—	2	—
System Dynamics	766, 767	2	1½	2	1½
Thesis	20	—	—	—	—
Option 5m, Materials Science					
Chemistry of Metals	805	2	—	2	—
Differential Equations of Mathematical Physics	2445	2	—	2	—
English	2140	1	—	1	—
Philosophy of Science	2040	2	—	—	—
Materials Science Laboratory	827	—	12	—	12

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Materials Science Seminar	826	–	3	–	3
Physics of Metals	823, 824	3	3	3	3
Thesis	20	–	–	–	–
And one of:					
Physical Electronics	738, 739	2	–	2	3
Materials Science Laboratory	827	–	3	–	3
Option 5nt, Nuclear and Thermal Power					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Control Systems	398, 399	1	–	2	3
English	2140	1	–	1	–
Heat Transfer	328	–	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Nuclear Engineering	670, 671	2	3	2	3
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	3	–	3
Thermal Energy Conversion	331, 332	3	3	3	3
Computational Methods	393	1	3	–	–
Thesis	20	–	–	–	–
Option 5p, Physics					
Electronic Circuits	778, 769	3	3	–	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electromagnetic Radiation and Matter	2541	2	–	2	–
English	2140	1	–	1	–
Molecular Physics and Statistical Mechanics	2543	2	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	6	–	6
Quantum Mechanics	2545	2	–	2	–
Wave Theory	790	2	–	3	–
Thesis	20	–	–	–	–

CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

(Course 6)

The chemical engineer is concerned with the development and operation of processes by means of which matter is chemically altered to a more useful form, and in the design, construction, operation and management of plant in which to effect such changes. Apart from such obviously chemical processes as those concerned with the production of acids, alkalis, salts, petroleum, rubber products, pulp and paper, explosives, paints and varnishes, soap, plastics, etc., there are many industrial processes where chemistry plays a part, or where a knowledge of chemistry is valuable. There is thus a wide field of endeavour for the chemical engineer. In order to equip a student to enter this field, the course in chemical engineering is intended to provide the student with training in the principles of the major divisions of chemistry and chemical engineering, together with an understanding of such other engineering subjects as thermodynamics, hydraulics, electricity, and mechanics of materials.

As part of the work of the Fourth Year each student is assigned a problem involving original investigation, in order to let him apply to some extent what he has learned, and to introduce him to the chemical literature. It also serves as an introduction to research for those who are attracted to it, and who, because of their basic training are equipped to carry on research in chemistry or chemical engineering at the graduate level or in laboratories outside the university.

For those students considering taking up the teaching of science as a profession, the nature and extent of the thesis subject in the Fourth Year may be modified to allow the student to take such other instruction as may be necessary to shorten the time required before becoming professionally qualified.

The subjects of instruction are shown in the following tables. In these tables reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	615, 614	2	9	–	–
Analytical Chemistry Laboratory	613	–	–	–	–
Calculus	2420, 144	2	1½	2	1½
Chemical Engineering Science Laboratory	619	–	–	–	7½
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Introduction to Mass and Heat Transfer	631	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	102	2	–	2	–
Physical Chemistry	2622	2	–	2	–
Process Calculations	620	–	3	–	3
Practical Experience	10	–	–	–	–

Third Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	633	1	1	1	1
Chemical Engineering Thermodynamics	640	2	–	2	–
Chemical Laboratory	627	–	6	–	6
Reaction Kinetics	625	1	–	1	–
Fluid Mechanics	337, 338	2	3	–	–
Engineering Thermodynamics	315, 316	2	–	–	3
Industrial Chemistry	630	–	–	3	–
Introduction to Mass and Heat Transfer	631	2	–	2	3
Organic Chemistry	628, 629	2	9	2	6
Practical Experience	10	–	–	–	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Chemical Engineering	653	–	–	–	3
Chemical Engineering Thermodynamics and Kinetics	655	2	–	2	–
Chemical Engineering Laboratory	652	–	9	–	–
Chemical Plant Design	651	2	6	–	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Industrial Management	396	1	–	–	–
Mass Transfer Operations	650	2	–	2	–
Organic Chemistry	654	–	–	2	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	10	–	–	–	–
Thesis	20	–	1	–	18

ELECTRICAL ENGINEERING

(Course 7)

Although electrical engineering, which includes the field of electronics, is concerned with a vast range of electrical phenomena characterized by power in microwatts at one extreme to power in megawatts at the other, and by frequencies in thousands of megacycles per second down to zero, the same fundamental principles underlie the whole range. It is the objective of the Electrical Engineering course to lay a sound scientific foundation for any of the particular areas which the student may eventually enter. Since a thorough grounding in the basic sciences is important, a large portion of the curriculum is devoted to such subjects as Mathematics, Mechanics, Chemistry and basic Electricity and Magnetism. Stress is laid on the calculation of circuits and fields, and on the fundamentals of electronics.

The application of electrical laws and phenomena to engineering practice is dealt with in a number of subjects such as Communication Systems, Feedback Control Systems, Power Systems, Microwave Engineering and Electric Machinery. In common with the other engineering courses, subjects in allied fields are included in the curriculum; for example, thermodynamics and physical metallurgy. Also, in recognition of the fact that the successful engineer frequently assumes an administrative or executive position, the curriculum includes some subjects, such as Economics, which serve to broaden the student's viewpoint beyond the strictly technical field.

Because so much fundamental material must be covered in the undergraduate curriculum, specialization is reserved for the post-graduate years when the student may pursue intensive studies in areas such as energy conversion, high-voltage phenomena, microwaves, plasmas, radio astronomy, bio-medical electronics, and feedback control systems.

The electrical engineer must treat the phenomena he encounters largely by mathematical analysis. It is important, therefore, that the student possess a natural aptitude for mathematics as well as qualities of imagination and abstract reasoning.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	2623	2	–	–	–
Calculus and Differential Equations	2421	2	2	2	2
Dynamics	352, 353	2	1½	1	1½
Economics	2720	2	–	2	–
Circuit Theory I	710	3	2	3	2
Electric and Magnetic Fields	711	2		2	
Electrical Measurements	712	–	–	2	–
Electrical Laboratory	713	–	3	–	3
Mechanics of Materials	106, 104	2	3	1	–
Physics II	2526	–	–	2	3
Programming and Numerical Methods	721	1	–	1	–
Practical Experience	10	–	–	–	–

Third Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	732	2	2	2	2
Circuit Theory II	733	3	–	2	–
Electric Machinery I	734	2	–	1	–
Electronic Circuits I	737	–	–	2	–
Electrical Problems	736	–	4	–	4
Electrical Laboratory	735	–	3	–	3
Electronics Laboratory	738	–	–	–	3
Heat Engineering Laboratory	318	–	3	–	–
Machine Design	367, 368	2	3	–	–
Physics of Metals	819, 820	–	–	2	1½
Physical Electronics	730	2	–	2	–
Thermodynamics	317	2	–	1	–
Practical Experience	10	–	–	–	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Computer Logic and Design	781	2	–	1	–
Control Systems	765, 767	2	1½	2	1½
Electronic Circuits II	768, 769	3	3	–	–
Electric Machinery II	763, 764	2	3	–	–
Electromagnetic Engineering	762	2	1	2	1
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Fluid Mechanics	346, 347	1	–	2	3
Philosophy of Science	2040	2	–	–	–
Thesis	20	–	1	–	1
Practical Experience	10	–	–	–	–
And one subject from each of Groups A, B, and C.					
Group A					
Communication Systems	770, 771	–	–	3	3
Electric Power Systems	779, 780	–	–	3	3
Group B					
Microwave Engineering	776, 777	–	–	2	1½
Electric Machinery III	774, 775	–	–	2	1½
Group C					
Acoustics	792, 793	–	–	2	1½
Illumination	794, 795	–	–	2	1½

METALLURGY AND MATERIALS SCIENCE
(Course 8)

"Metallurgy and Materials Science" is the study of the production, structure, and properties of the engineering materials used in structures, machines and devices.

Modern technology makes increasingly severe demands upon both metallic and non-metallic solids; in fact, it is difficult to think of an engineering project whose basic limitations do not reside in the materials which are available. For example, aerospace travel requires materials capable of withstanding extremes of heat, cold and pressure; the utilization of nuclear energy is limited only by materials which can withstand the effects of radiation and high neutron flux, while the transistor and the computer depend upon materials having special electrical and magnetic properties. As industry expands, the metallurgist or materials engineer will be called upon to play an increasingly important role in the economy.

The course is designed to place primary emphasis upon the fundamental principles which underly the chemical, physical and mechanical properties of solids. In the fourth year, each student is assigned an experimental problem involving original work and, where possible, this is related to the actual research in progress in the department. The student is, therefore, introduced to the methods of research.

The department is equipped with the most modern facilities for the study of the structure of materials, including X-ray diffractions, electron beam microprobe, optical equipment, together with facilities for producing and measuring high temperatures, high vacuum furnaces, etc.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	2624	–	3	–	3
Calculus	2420	2	–	2	–
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Inorganic Chemistry	617	1	–	2	–
Materials Science	832	2	–	2	–
Mathematical Analysis	383	–	1½	–	1½
Mechanics of Materials	105, 104	2	–	2	3
Physical Chemistry	2622	2	–	2	–
Physics—Heat and Optics	2525	2	3	–	–
Probability and Statistics	2423, 2424	2	2	2	2
Practical Experience	10	–	–	–	–

Third Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry of Metals	802, 803	2	3	–	6
Differential Equations	2432	2	–	2	–
Engineering Data Processing	3331, 3332	–	–	2	3
Fluid Flow and Heat Transfer	348	2	–	2	3
Materials Processing II	833	2	–	–	–
Materials Science (Session 1966–67 only)	832	2	–	2	–
Physics of Metals	821, 822	2	6	2	3
Thermodynamics in Metallurgy	810, 812	2	4	2	4
X-ray Crystallography	2901	–	2	–	2
Practical Experience	10	–	–	–	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry of Metals	805, 806	2	6	2	–
English	2140	1	–	1	–
Fluid Flow and Heat Transfer (Session 1966-67 only)	348	2	–	2	3
Materials Science Seminar	826	–	3	–	3
Metallurgical Problems Laboratory	814	–	2	–	2
Philosophy of Science	2040	2	–	–	–
Physics of Metals	823, 824	3	3	3	3
Physical Chemistry of Materials	813	2	–	2	–
Practical Experience	10	–	–	–	–
Thesis	20	–	6	–	9

GEOLOGICAL ENGINEERING

(Course 9)

Geology is the science of the earth. It includes, in a large sense, all knowledge of the earth—its origin, history, structure, composition and mineral wealth—and the physical, chemical and biological processes that change the earth. It spans a wide range of sciences and requires a thorough grounding in mathematics and the basic science and engineering disciplines to aid in a proper understanding of the subject and its many applications. The various branches of geology include geophysics, which is concerned with the investigation of the earth, particularly its structure and composition, by the methods of experimental physics; geochemistry, which may be defined broadly to include all parts of geology that involve chemical changes; and geobiology which deals with the totality of living things on the earth's surface in geologic time.

The first three years of the course in Geological Engineering provide a broad education in the fundamentals of geology and its associated disciplines. In the fourth year the course concentrates on the study of Economic Geology—the application of principles and methods of geology in the discovery, examination, evaluation and production of mineral, fossil fuel and water resources. An option in the last year allows the student to choose between the subjects Exploration Geophysics (2568, 2569) and Mine Operation and Administration (224, 226) thereby emphasizing either the search for or the development of mineral deposits.

Graduation from this course leads to employment in mineral and petroleum exploration and development. Graduates are prepared for advanced study towards the M.A.Sc. and Ph.D. degrees in a number of branches of geology including Economic Geology, Geochemistry, Structural Geology and Applied Geophysics.

The subjects of instruction are shown in the following tables. The subject numbers refer to detailed descriptions in the succeeding pages, e.g., Economics, 2720, page 117.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
A.C. Circuits	717, 718	2	1½	–	–
Calculus	2420, 144	2	1½	2	1½
Economics	2720	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	106, 104	2	–	1	1½
Mineralogy	2921	2	3	2	3
Mining	221	1	–	1	2
Optical Crystallography	2922	–	2	–	2
Physical Chemistry	2622	2	–	2	–
Principles of Geology	2920	2	3	2	3
Surveying	155	1	–	2	–
Practical Experience	10	–	–	–	–

Third Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Geological Field Trips	2937	–	–	–	–
Geology Field Camp	2936	–	–	–	–
Metallurgy	804	–	–	1	–
Mineral Identification Laboratory	2934	–	2	–	2
Petroleum Geology, Ground Water	2933	2	3	2	3
Petrology	2930	2	2	2	2
Photogrammetry	162, 163	2	3	–	–
Practical Experience	10	–	–	–	–
Stratigraphy and Sedimentation	2931	2	2	2	2
Structural Geology	2932	1	3	1	3
Survey Camp	158	–	–	–	–
Theory of Phase Equilibria	2935	2	–	2	
One of:					
Differential Equations	2432	2	–	2	–
Mining Technology	222	2	–	2	–
And one of:					
Modern World History	2330	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
English	2140	1	–	1	–
Geology of Canada	2948	1	–	1	–
Geological Field Trips	2947	–	–	–	–
Geophysics	2568, 2569	1	3	1	3
Metallurgy	808	1	–	1	–
Mineral Deposits	2940, 2941	2	–	2	3
Mine Operation and Administration	224, 226	2	–	2	3
Petroleum Geology and Ground Water	2933	2	–	2	3
Pleistocene Geology	2949	2	–	2	–
Practical Experience	10	–	–	–	–
Precambrian Geology	2944, 2945	2	3	–	3
Philosophy of Science	2040	2	–	–	–
Thesis	20	–	–	–	3

AEROSPACE STUDIES

A five-year program of study is offered to prepare the student for a career in the aerospace field. It includes the following elements: (*a*) an introduction to the fundamentals of mathematics, physics, and chemistry, (*b*) an introduction to aerodynamics, instrumentation, propulsion, structures and design, and (*c*) an advanced treatment of the subjects required for modern design and research in aerospace science and engineering such as hypersonic aerodynamics, flight dynamics, and space propulsion. Under (*a*) and (*b*) the student's training is necessarily broad and basic. The more advanced knowledge needed for the research, development, and design relevant to new aircraft and spacecraft is provided under (*c*) and is of particular significance. Parts (*a*) and (*b*) are provided in a four-year undergraduate course, but the final intensive training under (*c*) is left for a postgraduate (fifth) year.

The program of study that leads to status as a well-qualified aerospace engineer has been established in two parts as follows:

(i) *Undergraduate Course.* The student registers in the course in Engineering Science, subject to the entrance requirements given on page 16 of this Calendar. This course provides the requisite training in the fundamental sciences (see (*a*) above). The advanced subjects contained in the Aerospace option given in the third and fourth years are taught by the staff of the Institute for Aerospace Studies (see (*b*) above). The student will receive the degree of Bachelor of Applied Science upon completion of this part of the program.

(ii) *Graduate Course.* The student will then continue his five-year program (see (*c*) above) in the Institute for Aerospace Studies, as a candidate for the degree of Master of Applied Science or Master of Engineering. Details regarding entrance regulations and courses of study are given in the Calendar of the School of Graduate Studies. The facilities of the Institute are available to the student. For details of research projects, assistantships, scholarships and demonstratorships, students should consult the Annual Bulletin of the Institute.

It should be noted that a student who has graduated in another branch of engineering and who desires to qualify as an aerospace engineer may proceed directly with (ii) above, but in this case the course leading to the M.A.Sc. or M.Eng. degree must be arranged so that deficiencies in his undergraduate training are made up.

The facilities of the Institute are available for further graduate study leading to the Ph.D. Degree.

OUTLINE OF LECTURE AND LABORATORY SUBJECTS

On the pages that follow a brief description is given of the lectures and laboratory subjects prescribed in the preceding tables of curriculum. The numbers before the subjects are the reference numbers assigned in the tables. For example, 135, Descriptive Geometry, means the course of lectures indicated by this number in the table of curriculum for the First Year on page 28.

Where laboratory reports are to be written outside of assigned laboratory hours the maximum number of such reports is indicated in the description of the laboratory course concerned.

FACULTY REQUIREMENTS

10. Practical Experience.

Students in the courses listed below are required to have, before graduation, practical work of a nature acceptable to the department concerned. This may be obtained during the summer vacations but work done before entering the Faculty may also meet the requirements. Instructions will be issued by the departments concerning the type of work which is acceptable. Practical experience certificate forms may be obtained from the departments and should be returned there when completed.

Course 1	600 hours
Course 2	800 hours
Course 3	600 hours
Course 4	600 hours
Course 6	600 hours
Course 7	600 hours
Course 8	600 hours
Course 9	600 hours

20. Thesis

All courses, IV Year.

Every student in the Fourth Year is required to prepare a thesis on a approved subject. Instructions will be issued by the departments concerned.

In some cases written presentation is required, in others oral and written, or it may consist of a research problem followed by a written thesis or report.

DEPARTMENT OF CIVIL ENGINEERING

100. Applied Mechanics. Staff in Civil Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

This subject is divided into two parts, statics and dynamics.

Statics: The principles of statics are discussed, and applied to the composition and resolution of forces. A variety of applications are studied, including plane pin-jointed frames and simple three-dimensional structures.

Dynamics: Theoretical principles and practical applications are discussed for:

Particle motion on straight and curved paths; work energy and power; impulse and momentum; plane translation and rotation of rigid bodies.

Textbook: *Engineering Mechanics*—Higdon and Stiles (Second Edition).

101. Statics. R. A. Collins, J. Schwaighofer.

Course 5, I Year; 2 hrs. lectures per week, first term.

Translational and rotational resultants and equilibrants are discussed together with equivalent force systems in two- and three-dimensional space. Emphasis is placed on systems in equilibrium. A variety of applications is studied including frameworks, simple machines, and bending moments and shearing forces in beams.

Textbook: *Mechanics for Engineers: Statics*—Beer & Johnston (Second Edition).

102. Mechanics of Materials. I. C. Medland, J. Timusk.

Courses 4 and 6, II Year; 2 hrs. lectures per week, both terms.

In this subject, the fundamental theories of stress and strain are investigated as they apply to the selection of adequately proportioned materials to carry a given load in such engineering applications as tension, compression, torsional, and other members.

Textbook: *Mechanics of Materials*—Higdon, Ohlsen and Stiles.

103. Mechanics of Materials. R. A. Collins.

Course 5, II Year; 1 hr. lecture per week, both terms.

Basic relationships between force, stress, strain, and deflection of bodies made of various engineering materials are discussed. Beams, columns, shafts, tension members and pressure vessels are analysed and designed for strength and stiffness.

Textbook: *Mechanics of Materials*—Popov.

104. Mechanics of Materials Laboratory; General J. D. Barber, C. E. Helwig, K. Meipoom, R. G. Tress.

Courses 1, 3, and 8, II Year; 3 hrs. laboratory per week, second term.

Courses 4 and 7, II Year; 3 hrs. laboratory per week, first term.

Course 9, II Year; 3 hrs. laboratory, alternate weeks, second term.

An introduction to testing machines, strain and other measuring devices and standard specifications.

The experimental study of some engineering materials and structural members under applied load.

No laboratory report shall be written outside the assigned teaching hours.

105. Mechanics of Materials. J. D. Barber, S. M. Uzumeri.

Courses 1 and 8, II Year; 2 hrs. lectures per week, both terms.

An introduction to the elastic and inelastic behaviour of solids under various external loading conditions. Strains, stresses and deformations are determined for members subjected to tension, compression, torsion and bending and for pressure vessels by using basic strength of materials theories.

Textbook: *Mechanics of Materials*—Popov.

106. Mechanics of Materials. A. C. Davidson.

Courses 7 and 9, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

The fundamental relations among stress, strain and applied load are worked out for tension, compression, twisting and bending in the elastic and inelastic ranges, for various engineering materials. Buckling phenomena are examined for struts and columns. Numerical applications are done in lectures; and problems are assigned for study.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Snyder.

107. Mechanics of Materials. A. C. Davidson.

Course 3, II Year; 3 hrs. lecture per week, first term; 1 hr. lecture per week, second term.

In this subject the following are examined: behaviour of materials under applied loading or deformation; stress-strain relations for elastic bodies; simple tension, compression, torsion and bending of engineering components; inelastic behaviour, instability of structural and mechanical systems; engineering properties of materials; mechanical testing to obtain measures of ductility, strength and other engineering properties; yield flow and fracture of metals; fluctuating stresses, stress concentration and fatigue. Mohr's circle will be used in a number of stress relationships.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Snyder.

110. Mechanics and Materials II. J. Schwaighofer, J. Timusk.

Course 1, Group A, III Year; 2 hrs. lectures per week, both terms.

Cement and concrete technology; an introduction to the design of reinforced concrete members; behaviour of metals; special topics on bending of beams; failure theories; introduction to experimental stress analysis. Problems and laboratory under Course 113.

Textbooks: *Reinforced Concrete Fundamentals*—Ferguson; Concrete Manual by U.S. Bureau of Reclamation. *Mechanics of Materials*—Popov.

Reference book: *Concrete Technology I & II*—D. R. Orchard.

111. Structural Design. M. W. Huggins.

Course 1, Group A, III Year; 2 hrs. lectures per week, both terms.

An elementary study of the stress analysis and design of structures, structural members, and their details.

The work covered includes steel and timber tension members, compression members and flexural members, including box girders and plate girders and continuous as well as simple span beams. Welding, riveting and high tension bolting, as methods of connecting structural members, are studied. Design and analysis problems under Course 113.

Textbook: *Design of Steel Structures*—Gaylord and Gaylord.
Reference books: *Structural Problems*—Young and Morrison. *Plastic Design of Steel Frames*—Beedle.

112. Structural Theory I. C. F. Morrison.
Course 1. Group A, III Year; 3 hrs. lectures per week, second term.
The stress analysis of simple span, continuous and cantilever trusses. Influence lines and index stresses. Truss deflections by analytical and graphical methods. Analysis of statically indeterminate trusses, beams and frames by various methods.
Problems under Course 113.
Textbook: *Structural Theory*—Sutherland and Bowman.

113. Structural Laboratory. Staff in Civil Engineering.
Course 1, Group A, III Year; 7½ hrs. per week, first term, 6 hours per week, second term.
Problems and laboratory to complement subjects 110 and 112.
Study periods of design and analysis to complement subject 111; during the fall term two timber structures and during the spring term one steel structure are designed. The designs are discussed and evaluated.
Three hours per week of the above time in the first term will be devoted to the cements and concrete laboratory; the balance will be on problems and design.

114. Structural Engineering I. G. T. Will.
Course 1, Group B, III Year; 2 hrs. lectures per week, both terms.
An introduction to the analysis and design of structures, structural members and their details.
The work covered includes steel and timber columns, tension members and connections.
Problems under Course 115.
Textbooks: C.I.S.C. Steel Construction Series—Book Two. *National Building Code of Canada.*
Reference book: *Elementary Structural Analysis*—Norris and Wilbur.

115. Structural Laboratory. G. T. Will.
Course 1, Group B, III Year; 3 hrs. alternate weeks in first term, and 3 hrs. per week, second term.
Design and analysis problems to complement subject 114.

116. Reinforced Concrete I. S. M. Uzumeri.
Courses IA, 1C and 1D, IV Year; 2 hrs. lectures per week, both terms.
Ultimate and working strength behaviour of Reinforced Concrete members subjected to flexure, axial compression, shear,

combined axial compression and flexure, combined flexure and shear, and bond.

Relation between research results and current specifications for design of members.

Design of simple and continuous beams, one way, two way and flat slabs, columns, retaining walls and footings.

Problems under course 120 for course 1A. Problems under course 121 for courses 1C and 1D.

Reference books: *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

117. Reinforced Concrete II. M. W. Huggins.

Course 1A, IV Year; 2 hrs. per week, both terms.

Ultimate design; prestressed concrete; composite design; design of building frames, arches and bridges. Behaviour of reinforced concrete members.

Problems under Course 120.

Reference books: *Theory & Practice of Reinforced Concrete*—Dunham. *Reinforced Concrete Design*—Sutherland and Reese. *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

118. Behaviour and Design of Steel Structures. D. J. L. Kennedy.

Course 1A, IV Year; 2 hrs. per week, both terms.

A continuation of Course 111. The behaviour of structural elements and structures is discussed and related to design methods and criteria. Topics include, repeated loading, brittle fracture, welding, connections, buckling, inelastic behaviour, analysis and design of metal structures by ultimate load procedures.

Problems under Course 120.

Textbooks: *Structural Steel Design*—Beedle *et al. Canadian Institute of Steel Construction*—Steel Construction Series, Books 1, 2, 3.

119. Structural Theory II. G. Kani, R. A. Collins.

Course 1A, IV Year; 2 hrs. per week, first term, 3 hrs. per week, second term.

Analysis of statically indeterminate structures; influence lines for statically indeterminate structures; the use of strain energy, slope deflection, moment distribution, column analogy and Kani methods for the analysis of frameworks; an introduction to plate theory.

Problems under Course 120.

120. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.

Course 1A, IV Year; 12 hrs. per week, first term and 10 hrs. per week, second term.

Project, problems and Mechanics of Materials laboratory to supplement courses 116, 117, 118, 119 and 140.

121. Structural Laboratory. Staff in Civil Engineering.
Courses 1C and 1D, IV Year; 3 hrs. per week, both terms.
Design and analysis problems, and testing laboratory to supplement course 116.

122. Structural Engineering II. C. E. Helwig.
Course 1B, IV Year; 2 hrs. per week, both terms.
Cements and concrete; design and analysis of reinforced concrete members. Problems and concrete laboratory under course 123.
Textbook: *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Wilson.

123. Structural Laboratory. C. E. Helwig.
Course 1B, IV Year; 4½ hrs. per week, first term and 3 hrs. per week, second term.
Design and analysis problems to supplement course 122. In the first term 3 hours per week will be devoted to Cements and Concrete laboratory.

126. Structural Engineering. J. D. Barber.
Course 3, IV Year; 2 hrs. lectures per week, first term.
The fundamental principles of Statics and Mechanics of Materials are applied to the design and analysis of structural members and their connections. Problems are worked in class and in the drafting room (Subject 127).
Moving loads on simply supported beams; tension, compression and flexural member details.
Textbook: *Design of Steel Structures*—Gaylord & Gaylord.

127. Structural Engineering Problems. J. D. Barber.
Course 3, IV Year; 3 hrs. per week, first term.
Problems supplementing the work covered in lecture course 126.

130. Construction Management and Business. M. G. Tallon, S. G. Hennessey.
Course 1, IV Year; 2 hrs. lectures per week, second term.
A study of heavy and building construction, including job planning and organization, construction methods and equipment, superintendence, job records, labour relations and safety procedures. Elements of business organization and management with an introduction to the principles of control through accounting records and financial statements.

135. Descriptive Geometry. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, P. Wodzianski.
All courses, 1 Year; 1 hr. lecture per week, both terms.
These lectures deal with the principles of orthographic, oblique and perspective projection and their use in solving problems of straight lines, planes, and curved surfaces.
Textbook: *Descriptive Geometry*—Watts and Rule.

137. Engineering Problems and Drawing. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, P. Wodzianski.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 6 hrs. per week, both terms.

Drawing and lettering. Problems in descriptive geometry and applied mechanics. An introduction to graphical methods of solving engineering problems, e.g., nomography, empirical equations, graphical algebra and calculus, projective geometry. Plotting of original surveys for courses 1, 2 and 9.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

138. Engineering Problems and Drawing. C. A. Wrenshall, K. A. Selby, V. P. Borecky.

Course 1, II Year; 6 hrs. per week, both terms.

Problems in descriptive and projective geometry, nomography, graphical calculus. Graphs and empirical equations. Structural drawing. Plotting of original surveys. Problems in mathematics.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

139. Engineering Mathematics Problems. G. T. Will.

Course 1, III Year; 3 hrs. per week, alternate weeks first term, 3 hrs. per week, second term.

Problems based on the content of Lecture Course 141.

140. Mathematical Applications. R. A. Collins.

Courses 1A, 1C, 1D, IV Year; 2 hrs. lecture per week, first term.

The formation, discussion and solution of certain types of civil engineering problems by numerical methods, including relaxation techniques.

141. Engineering Mathematics. G. T. Will.

Course 1, III Year; 2 hrs. lectures per week both terms.

The solution of differential equations and their application in Civil Engineering.

Textbook: *Applied Differential Equations*—Spiegel.

142. Engineering Problems and Drawing. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky.

Course 5, I Year; 3 hrs. per week, both terms.

Drawing and lettering. Problems in descriptive geometry and applied mechanics.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

144. Mathematics Problems. K. A. Selby.

Courses 6 and 9, II Year; 3 hrs. per week, alternate weeks, both terms.

Problems in mathematics.

153. Surveying. O. J. Marshall. B. J. Haynes.

Course 1, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Simple, reverse, compound and spiral curves as applied to Highway and Railroad surveying. Main features of mine and hydrographic surveying. Construction surveying dealing with cross sectioning, earthwork, quantities, mass or haul diagram, super elevation, vertical curves, and layout of roads and sewers.

Textbook: *Route Surveys*—Skelton.

154. Surveying Laboratory. O. J. Marshall, B. J. Haynes, H. L. Macklin, S. G. Bird.

Course 1, II Year; 3 hrs. per week, both terms.

First Term: Field problems, in levelling, traversing, curves and topography.

Second term: Surveying computations, including traversing, curves, astronomy, and earth work quantities.

155. Surveying. H. L. Macklin.

Course 9, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Mine surveying, with problems related thereto. Simple curves, stadia and plane table topographical surveying. Practical determination of time, latitude and azimuth by methods adapted to the surveyor's transit.

Textbook: *Surveying for Civil Engineers*—Kissam.

157. Practical Astronomy. H. L. Macklin.

Course 1, II Year; 2 hrs. lectures per week, second term.

The derivation of formulae and their application to the solution of spherical triangles and practical problems. Practical determination of time, latitude and azimuth by methods adapted to the use of the surveyor's transit. The subject will be designed to enable the student to carry out these observations at the Summer Survey Camp.

Textbooks: *Practical Astronomy*—Nassau; *Textbook of Field Astronomy*—British War Office.

158. Survey Camp. Staff in Civil Engineering.

Course 1, III Year; Aug. 15 to Sept. 16—Dorset or Gull Lake; Course 9, III Year; Sept. 6 to Sept. 16—Gull Lake.

Course 1:

(*a*) Secondary Triangulation and Base Line Measurements.
(*b*) Highway and Railway Location.
(*c*) Cross Sectioning and Computation of Earthwork.
(*d*) Stadia and Plane Table Topography.
(*e*) Observations for Time, Azimuth, and Latitude.

Course 9:

(*a*) Topographic Surveying and Mapping.
(*b*) Underground Surveying, including Shaft Plumbing and Use of Mine Surveying Instruments.

(*c*) Route Surveys, Curve Layout, and Earthwork Quantity Computations.

(*d*) Astronomic Observations for Time and Azimuth.

Students in Courses 1 and 9 will be required to take the Survey Camp between the Second and Third Years.

Application to defer attendance at the Camp must be made to the Secretary of the Faculty before July 15.

159. Least Squares. H. L. Macklin.

Course 1B, III Year; 3 hrs. laboratory per week, first term.

The general principles of probability of errors, elementary problems illustrating the application of Least Squares to the adjustment of observations, empirical constants and formulae.

No laboratory reports shall be written outside the assigned teaching hours.

Textbooks: *Least Squares in Engineering*—Marshall and Macklin; *Survey Adjustment and Least Squares*—H. F. Rainsford.

160. Geodetic Engineering. O. J. Marshall.

Course 1B, III Year; 2 hrs. lectures per week, second term.

Principles, equipment and methods of geodetic survey involving triangulation, traverse and levelling of high precision; elementary geodesy and map projections.

161. Geodetic Engineering Laboratory. O. J. Marshall, B. J. Haynes.

Course 1B, III Year; 3 hrs. per week, second term.

Problems and computations supplementing the work covered in subject 160.

162. Photogrammetry I. J. Vlcek.

Courses 1B and 9, III Year; 2 hrs. lectures per week, first term.

Outline of photogrammetry. Central projection. Camera: interior orientation. Stereoscopic vision and methods of viewing stereo. Terrestrial photogrammetry: geometry of stereo-pairs, stereocomparator, error analysis. Aerial photogrammetry: camera and film, photography, geometry of single picture, radial line triangulation, geometry of stereo-pairs, analysis of model deformations and parallax corrections in near vertical pictures. Simple instruments for details transfer from photo to map.

163. Photogrammetry I. Laboratory. J. Vlcek.

Courses 1B and 9, III Year; 3 hrs. per week, first term.

Laboratory work supplementing the lecture course 162.

164. Photo Interpretation. S. G. Bird.

Course 1B, III Year; 2 hrs. lectures per week, second term.

The use of aerial photographs in geology, land use, forestry, etc.; methods of extracting, and displaying the information available—all based on the use of a large collection of diversified photography.

165. Photo Interpretation Laboratory. S. G. Bird.
Course 1B, III Year; 3 hrs. per week, second term.
Laboratory work supplementing the lecture course 164.

167. Survey Camp. O. J. Marshall, H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; Aug. 22 to Sept. 16, Gull Lake.
Triangulation, trilateration, electronic distance measurements, traverses, levelling and astronomical observations by precise methods.

168. Geodetic Adjustments. R. C. Gunn.
Course 1B, IV Year; 1 hr. lecture per week, both terms.
The theory of adjustment of geodetic measurements. The adjustment of triangulation, trilateration and level nets. The variance of the observed and the adjusted quantities. Curve fitting, and the application of the electronic computer to survey problems.

169. Geodetic Adjustments Laboratory. R. C. Gunn.
Course 1B, IV Year; 3 hrs. laboratory per week, both terms.
Adjustment of observations. Solution of problems by desk calculation and electronic computer.

170. Photogrammetry II. J. Vlcek.
Course 1B, IV Year; 1 hr. lecture per week, both terms.
Review of elementary matrix theory. Theory of model restitution. Plotting instruments. Methods of instrumental aerial triangulation and its adjustments. Introduction to analytical methods of aerial triangulation.

171. Photogrammetry II. Laboratory. J. Vlcek.
Course 1B, IV Year; 3 hrs. laboratory per week, first term; 3 hrs. laboratory, alternate weeks, second term.
A laboratory course supplementing subject No. 170.

172. Astronomy. H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; 1 hr. lecture per week, first term.
Precise determination of time, latitude, longitude and azimuth as applied to geodetic surveys.

173. Astronomy Laboratory. H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; 3 hrs. laboratory per week, first term.
Observations and problems to accompany subject 172.

174. Engineering and Legal Surveys. B. J. Haynes.
Course 1B, IV Year; 2 hrs. lecture per week, first term, and 1 hr. lecture per week, second term.
Construction surveying problems dealing with prismoidal volumes and corrections, hydrographic surveying, tunnel surveying, circular curve intersections, area computations, chronological order of land subdivision and layout from early township patterns to present-day subdivisions, the weighing of survey evidence in the retracement of construction and legal surveys, and the preparation of legal surveys.

175. Geodesy and Electronic Surveying. R. C. Gunn.

Course 1B, IV Year; 2 hrs. lectures per week, both terms.

Ellipsoidal geometry, deflections of the vertical, reduction of geodetic measurements to the ellipsoid, geodetic position computations, electronic surveying, map projections.

176. Geodetic Computation Laboratory. R. C. Gunn.

Course 1B. IV Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.

Problems in geodetic computations, the reduction of electronic distance measurements, the calculation of geodetic positions, map projection co-ordinates.

180. Sanitary Engineering. A. P. Bernhart.

Course 1, III Year; 2 hrs. lectures per week, first term.

The objective of Sanitary Engineering and Pollution Control. Basic outline of problems of urbanization and the natural cycle of water. Water Purification. Treatment of domestic and industrial waste waters. Municipal Services—water mains, sanitary sewers, storm water drainage, garbage disposal. Air Pollution Control—equipment and planning considerations.

181. Air and Water Resources. A. P. Bernhart.

Course 1C, IV Year;

2 hrs. lectures per week, first term.

3 hrs. lectures per week, second term.

Water Resources: Natural cycle of water. Pollution by urban developments. Self-purification of natural water bodies. Watershed planning.

Water Purification: Screens, coagulation, sedimentation, filtration, chlorination, fluoridation, softening, iron removal, pumps.

Waste Water Treatment: Screens, grit removal, sedimentation, activated sludge process, trickling filters, chlorination, tertiary treatment, sludge digestion and dewatering. Industrial waste waters.

Air Resources: Natural air movements, micro climates. Causes, effects, history and disasters of air pollution. Aerosols and gaseous pollutants. Control by planning and cleanliness. Dust collectors, gas washers and absorbers, electro-static precipitators.

Pollution Control: As one problem of urbanization, the engineer's responsibility toward the society.

182. Municipal Engineering and Planning; Sanitary Chemistry. A. P. Bernhart, G. W. Heinke.

Course 1C, IV Year; 2 hrs. lectures per week, both terms.

Planning: Units of urban planning and their layout; aspects and implementation of planning.

Roads: Layout of systems, cross sections, construction.

Water Supply: Long distance transmission, distribution.

Sanitary and storm sewers: Systems, pumping stations, drainage.

Complete service systems for urban areas: design, administration and financing.

Analysis of Water Pollutants: Physical, chemical, biological. (Oxygen, nitrogen, carbon and iron; turbidity, hardness; micro-organisms.)

183. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.

Course 1C, IV Year; 7½ hrs. per week, first term; 7 hrs. per week, second term.

Thesis project and design problems supplementing courses 140, 181, 182, 187.

Several inspection field trips and reports on Water and Wastewater Plants, Subdivision Construction, Airpollution Control Installations.

Laboratory work on standard testing methods for air and water pollution.

Several field and laboratory reports.

185. Highway Engineering. M. M. Davis.

Course 1, III Year; 2 hrs. lectures per week, first term.

Organization, administration, economics and planning of rural highways; highway materials and paving; principles of location, design, construction and maintenance.

Textbook: *Highway Engineering*—Oglesby and Hewes, 2nd Edition.

Reference books: *The Highway Improvement Act—Ontario Highway Standards and Specifications*—Department of Highways of Ontario. *Soil Mechanics for Road Engineers*—D.S.I.R.—H. M. Printer, *Policy on Geometric Design of Rural Highways*—A.A.S.H.O.

186. Municipal Planning, Administration and Transportation. M. M. Davis, H. L. Macklin, D. F. D. Pinker.

Course 1, III Year; 3 hrs. lectures per week, second term.

Contemporary concepts in town and regional planning and their theoretical, practical and legal applications as applied in Canada.

Organization of municipal government, municipal finance, legislation governing municipal operation, role of the municipal engineer and private practitioner in public works, provisions of municipal services.

Urban and regional growth as affected by transportation, trends, demands, characteristics and capacities, co-ordination with land use and integration with other services.

187. Traffic Engineering. R. M. Soberman.

Course 1C, IV Year; 2 hrs. lectures per week, second term.

Course 1D, IV Year; 2 hrs. lectures per week, first term.

Urban transportation planning, methods of project evaluation,

characteristics of traffic flow, and traffic control at intersections.

Textbook: *Traffic Engineering Handbook.*

References: *Principles and Techniques of Predicting Future Demand for Urban Area Transportation*—Martin, Memmott, and Bone. *Traffic Engineering*—Matson, Smith and Hurd.

188. Transportation Engineering. M. M. Davis, R. M. Soberman.

Course 1D, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Transportation systems: highway, railroad, shipping, pipelines, conveyors, airports. Structural design of pavements. Theory of traffic flow.

Reference books: *Introduction to Transportation Engineering* —Hay; *Planning & Design of Airports*—Horonjeff; *Railroad Engineering*—Hay; *Soil Mechanics for Road Engineers*—D.S.I.R.; *Principles of Pavement Design*—Yoder; *Poisson & Traffic*—Eno Fndn.

189. Air Photo Interpretation. S. G. Bird.

Course 1D, IV Year; 1 hr. lecture per week, first term.

Analysis and interpretation of aerial photographs for the prediction of engineering properties of soils.

191. Soil Mechanics. F. A. De Lory.

Course 1, III Year; 2 hrs. lectures per week, first term.

Identification and classification of soils for engineering purposes; weight volume relationships, compaction; permeability and drainage characteristics; consolidation; field exploration and sampling; stress-deformation characteristics; shearing strength.

Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

192. Soil Mechanics and Foundations. F. A. De Lory, E. I. Robinsky.

Course 1A, C, D, IV Year; 2 hrs. per week, first term; 1 hr. per week, second term.

Shearing strength of soils, consolidation and settlement, slope stability, bearing capacity, footings, retaining walls, braced cuts, piling, dewatering.

Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

193. Earth Structures and Foundations. F. A. De Lory, E. I. Robinsky.

Course 1D, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Properties of unsaturated soils, fills, embankments, earth and rockfill dams, seepage, flow nets, sheet pile bulkheads, cellular cofferdams, geotechnical processes, tunnels, underpinning.

Reference books: *Soil Mechanics in Engineering Practice*— Terzaghi and Peck; *Pile Foundations*—Chellis; Proceedings of Soil Mechanics Conferences.

195. Soil Mechanics and Highway Laboratory. F. A. De Lory, E. I. Robinsky, R. M. Soberman.

Course 1, III Year; 3 hrs. per week, first term.

A series of laboratory and problem periods to accompany courses in Soil Mechanics (191) and Highway Engineering I (185).

196. Soil Mechanics Laboratory. F. A. De Lory, E. I. Robinsky.

Courses 1A and 1C, IV Year; 2 hrs. laboratory per week, second term.

Course 1D, IV Year; 2 hrs. laboratory per week, first term.

Laboratory experiments and testing to accompany Soil Mechanics and Foundations (192).

No laboratory reports to be written outside assigned laboratory hours.

197. Air Photo Interpretation Laboratory. S. G. Bird.

Course 1D, IV Year; 3 hrs. laboratory per week, first term.

Laboratory periods to accompany Air Photo Interpretation (189).

198. Thesis Project, Laboratory and Seminar. Staff in Civil Engineering.

Course 1D, IV Year; 4 hrs. per week, first term; 9 hrs. per week, second term.

Problem and laboratory periods to accompany subjects 140, 188 and 193.

DEPARTMENT OF MINING ENGINEERING

221. Mining. H. R. Rice, W. A. M. Hewer.

Course 9, II Year; 1 hr. lecture per week, both terms, and 2 hrs. laboratory per week, second term.

A combined lecture and laboratory subject in the principles of mining and its unit processes. Emphasis is placed on the statistical approach to sampling calculations.

222. Mining Technology and Mineral Dressing. H. R. Rice, S. E. Wolfe.

Course 9, III Year; 2 hrs. lectures per week, both terms.

An introduction to mining practice with emphasis on current mining methods as applied to geological situations and stress environments; fundamental principles and current practices in mineral beneficiation processes.

224. Mine Operation and Administration. H. R. Rice.

Courses 2 and 9, IV Year; 2 hrs. lectures per week, both terms.

Mine operation with special attention paid to mine services; administration dealing with aspects of economics, industrial engineering, finance, and industrial relations.

225. Mining Laboratory. H. R. Rice.

Course 2, IV Year; 2 hrs. laboratory per week, first term; 6 hrs. laboratory per week, second term.

A problem which progresses from essential geological data, to a complete design of the related mine, which integrates the principles of mine economics, selection of mining rates, ore-reserve calculations, and plant design.

226. Mining Laboratory. H. R. Rice.

Course 9, IV Year; 3 hrs. laboratory per week, second term.

Problems in mine layout involving shaft location and size; mine development; choice of stoping methods, mining rate, and mine equipment; time and cost schedules; ore reserve calculations.

244. Ore Dressing. S. E. Wolfe.

Course 2, IV Year; 1 hr. lecture per week, both terms.

The subjects covered are extensions of those in 241, 242, and 243; cyanidation, flotation processes and techniques, the current practice at milling plants, and problems associated with milling.

245. Ore Dressing Laboratory. S. E. Wolfe.

Course 2, IV Year; 6 continuous hours per week, first term.

Advanced work coordinated with lecture subject 244 and pertaining to ore dressing appliances, the handling in bulk of finely divided solids, the selective flotation of sulphides, ore testing, and pilot plant mill runs.

251. Mine Ventilation Laboratory. The Staffs in Mining and Mechanical Engineering.

Course 2, IV Year; 3 hrs. laboratory per week, first term.

Experiments in the laboratories and problems in the study room to give the student some practice in the use of ventilation test equipment, and the solution of ventilation problems. An aggregate of about ten off-campus study hours may be required in preparation of some reports. This subject relates to subject 321.

275. Thesis Project, Laboratory and Seminar. The staff in Mining Engineering.

During the Fourth Year of his Course, each student is required to select an area of investigation suitable to the Department and to give both oral and written findings arising from his pursuit of it. General instructions are given to the student before the close of the preceding Session in order to assist a considered choice.

DEPARTMENT OF MECHANICAL ENGINEERING

302. Engineering Thermodynamics. A. B. Allan.

Course 1, II Year; 2 hrs. lectures per week, second term.

The fundamentals of engineering thermodynamics. The First and Second Laws. Properties of substances. Heat transfer. Heat exchangers. Compressors, fans, pumps, reciprocating engines and turbines. Vapour and gas power cycles. Refrigeration. Air-conditioning.

Textbook: *Basic Thermodynamics*—Brown.

303. Elementary Heat Engineering. P. B. Hughes.

Course 3, II Year; 2 hrs. lecture per week, second term.

The history and development of heat engines, the principles upon which they operate, and the characteristic features of the different kinds of engines used in practice. The First and the Second laws of thermodynamics.

Textbook: *Elements of Thermodynamics and Heat Transfer*—Obert and Young.

308. Heat Engineering. F. C. Hooper, W. A. Wallace.

Course 3, III Year; 2 hrs. lecture per week, first term; 1 hr. lecture per week, second term.

A continuation of subject 303 and complementary to subject 309, this course deals with steam generators including combustion calculations, fuel and exhaust product analysis, and boiler testing and design; with internal combustion engines; with heat transmission; and with psychrometry and air conditioning.

Textbook: *Power Plant Theory and Design*—Potter.

Reference book: *A.S.H.R.A.E. Guide.*

309. Engineering Thermodynamics. F. C. Hooper.

Course 3, III Year; 2 hrs. lectures per week, both terms.

Continuation of subject 303.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer. Regeneration.

Textbook: *Elements of Thermodynamics and Heat Transfer*—Obert and Young.

310. Heat Engineering Laboratory.

Course 3, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subjects 303, 308 and 309. The experimental work, conducted on a broad range of heat and power equipment, is intended to offer experience in the design, organization and execution of experimental investigations of thermal apparatus, in the application and evaluation of the associated instrumentation, in the treatment of the data, and in the interpretation and reporting of the work.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

311. Engineering Thermodynamics. W. J. Moroz.

Course 4, III Year; 2 hrs. lectures per week, second term.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles used in practice for steam and gas power plants, and for refrigerating

plants. Reciprocating engines, turbines and compressors. Heat transfer.

Textbook: *Thermodynamics of Heat Power*—Faires.

312. Heat Engineering Laboratory.

Course 4, III Year; 3 hrs. laboratory per week, second term.

This laboratory is complementary to lecture subject 311. Selected experiments are conducted in illustration of the methodology of experimental investigation of the external characteristics of thermal devices and systems, with special attention given to the peculiar interests of the engineer primarily concerned with economic considerations.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

313. Heat Engineering. C. H. Miller.

Course 5nt, III Year; 1 hr. lecture per week, both terms.

This course consists of a study of the fundamental concepts of macroscopic thermodynamics, and their applications to closed and open dynamic systems. An examination of the principal power cycles is undertaken in relation to the properties of the working media involved. Emphasis is placed on a thorough understanding of the three basic laws of thermodynamics.

Textbook: *Concepts of Thermodynamics*—Obert.

Reference books: *Engineering Thermodynamics*—Hall and Ibele.

Thermodynamics—Van Wylen.

314. Heat Engineering Laboratory.

Course 5nt, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subject 313. The course emphasizes the philosophy and techniques used in the experimental investigation of the performance of heat engineering equipment.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

315. Engineering Thermodynamics. P. B. Hughes.

Course 6, III Year; 2 hrs. lecture per week, first term.

The theory and practice of heat engines, including a study of fundamental principles involved, an appraisal of theoretical developments, and a survey of the corresponding practical applications.

Textbook: *Thermodynamics of Heat Power*—Faires.

316. Heat Engineering Laboratory.

Course 6, III Year; 3 hrs. laboratory per week, second term.

This laboratory is complementary to lecture subject 315. Experiments are conducted on heat engineering equipment presenting testing and control problems similar to those encountered in the process industries.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

317. Thermodynamics. A. B. Allan.

Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

A development of the fundamental laws of thermodynamics and of their application in engineering. Internal combustion and steam power, refrigeration, heat transfer, psychrometry and air conditioning.

Textbook: *Thermodynamics of Heat Power*—Faires.

318. Heat Engineering Laboratory.

Course 7, III Year; 3 hrs. laboratory per week, first term.

This laboratory is complementary to lecture subject 317. Particular emphasis is placed on the experimental determination of the control and output characteristics of prime movers and of the energy balances in heat power plants.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

321. Mine Ventilation and Allied Problems. W. J. Moroz.

Course 2, IV Year; 2 hrs. lectures per week, first term.

Ventilation problems in Canadian mines, including the use of ventilation equipment, selection of fans, testing equipment, ventilation studies, the silicosis problem, fire control, etc.

322. Thermal Energy Conversion I. P. B. Hughes, D. G. Andrews.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

A continuation of subjects 308 and 309, and complementary to subject 323, this course deals with the plants and processes used in major power production. The overall design and heat balance in steam power plants is considered, and their components are examined. Both conventional fossil fuel and nuclear energy sources are considered. New developments and trends, such as magnetohydrodynamic power generation, are introduced.

Textbook: *Power Plant Theory and Design*—Potter.

323. Thermal Energy Conversion II. W. A. Wallace.

Course 3, IV Year; 2 hrs. lectures per week, second term.

A continuation of subjects 308 and 309, and complementary to subject 322, this course deals with non-central power production as for shaft power, propulsion, and similar applications. A survey of present and potential fuel resources. Operating cycles and characteristics of internal combustion engines, including reciprocating, rotary positive and gas turbine types. Rockets and ramjets. Design factors. The principles and potential of devices under current development, including fuel cells, thermoelectric converters and similar primary power producers.

Reference book: *The Internal Combustion Engine*—Taylor and Taylor.

324. Heat Engineering Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

This laboratory is complementary to lecture subjects 322 and 323. It is an extension of the third year laboratory, subject 310, with an increased demand for individual judgment and a professional outlook.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

328. Heat Transfer. F. C. Hooper.

Course 5nt, IV Year; 2 hrs. lecture per week, second term.

Steady state and transient conduction, surface and gas radiation, convection, boiling, condensation and combined mechanisms are considered. Special attention is given to analogue and computational procedures and to consideration of the manner in which novel or complex problems may be approached.

Textbook: *Heat Transmission*—McAdams.

331. Thermal Energy Conversion. F. C. Hooper, W. J. Moroz, A. B. Allan.

Course 5nt, IV Year; 3 hrs. lectures per week, both terms.

The thermodynamics and gas dynamics of thermal energy conversion. Steam power cycles, nuclear reactor and fossil fuel energy sources, magnetohydrodynamic power generation, fuel cells, combustion, refrigeration, new trends and research developments.

332. Heat Engineering Laboratory.

Course 5nt, IV Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture course 331, and an extension of course 314. The techniques of testing, the design of experiments, the application of instrumentation, and the organization and reporting of performance tests are emphasized.

333. Fluid Mechanics. G. R. Lord, W. D. Baines.

Courses 1 and 3, III Year; 2 hrs. lectures per week, both terms.

Development and discussion of the fundamental principles and Engineering applications of fluid flow. Influence of fluid density, weight, compressibility and viscosity on fluid motion are considered. Equations for particle motion and stream tube are derived. Dimensional analysis and similarity are discussed. Applications are made to fluid measurements, flow in pipes and open channels and resistance and lift of submerged bodies.

334. Fluid Mechanics Laboratory.

Courses 1 and 3, III year; one 3 hr. laboratory period per week, second term.

This laboratory course is planned to illustrate the principles considered in the lecture courses in fluid mechanics. Experimental

work in the laboratory utilizes a wide variety of apparatus and equipment concerned with fluid flow, while problems undertaken in the study room provide a link with general engineering practice.

337. Fluid Mechanics. L. E. Jones, P. L. Betts.

Courses 4 and 6, III Year; 2 hrs. lectures per week, first term.

The fundamentals of fluid flow as generally encountered in industry. Fluid properties, fluid statics, energy relations, dimensional analysis and dynamic similarity, flow in pipes and channels, resistance of submerged bodies, effects of viscosity and compressibility, lubrication, pumps and other hydraulic machines.

338. Fluid Mechanics Laboratory.

Courses 4 and 6, III Year; 3 hrs. laboratory per week, first term.

A course of laboratory experiments and design problems to permit of correlating flow fundamentals with industrial applications.

339. Fluid Mechanics. J. F. Keffer.

Courses 5c and 5nt, III Year; 2 hrs. lectures per week, both terms.

A course presenting the fundamentals of continuum fluid motion. Introductory concepts; kinematics and dynamics of flow; irrotational motions; viscous laminar and turbulent flows, thermodynamic relationships; gravity effects, applications.

340. Fluid Mechanics Laboratory.

Courses 5c and 5nt, III Year; 3 hrs. laboratory per week, both terms.

Problems and experiments related to subject 339.

341. Hydraulic Engineering. H. L. Leutheusser.

Course 1, IV Year, Option C; 2 hrs. lectures per week, both terms.

Applications of fluid mechanics to civil engineering problems, particularly discussion of flow in pipes and open channels, surge tanks, water hammer, pumps and turbines. Theory and applications of hydrology including precipitation, run-off, snowmelt, ground water, evaporation and hydrograph analysis.

342. Hydraulic Engineering Laboratory.

Course 1, IV Year, Option C; one 1½-hr. laboratory period per week, first term; one 3-hr. laboratory period per week, second term.

Experimental studies of hydraulic models, turbines and pumps are carried out. Problems assigned in the study rooms deal with channel flow and other hydraulic features connected with water power installations, flood control, water supply and drainage systems.

343. Hydraulic Engineering. P. L. Betts.

Course 1, IV Year, Options A, B, D; 2 hrs. lectures and 3 hrs. laboratory per week, second term.

The general field of hydraulic engineering is studied under the topics: hydrology; ground and surface water; drainage, flood control, power and navigation systems; municipal and industrial applications; model studies; principles of design, operation, and field investigation.

344. Hydraulics. G. R. Lord.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

The general field of applied hydraulics and fluid mechanics is studied under the topics: hydrology; hydro-electric power plants and auxiliaries; conservation and flood control; canals, pipelines, etc., under both steady and unsteady conditions; hydraulic machinery, fans, compressors, turbines, pumps, etc., design, selection and operation; power and control circuits; flow of compressible fluids; similarity and model investigations; industrial applications.

345. Hydraulic Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

Experimental work is carried out in the laboratory on various types of pumps, turbines, fans, centrifugal compressors and on hydraulic models. In addition computation problems involving open channel flow, water power studies, pumps and turbine studies, water hammer phenomena, fans and ductwork and other advanced flow problems are considered. General problems involving compressibility of gases are considered.

346. Fluid Mechanics. J. F. Keffer.

Course 7, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Fundamental presentation of fluid flow; introductory concepts; kinematics and dynamics of flow; potential flow; laminar and turbulent flows; magnetohydrodynamic concepts; applications.

347. Fluid Mechanics Laboratory.

Course 7, IV Year; 3 hrs. laboratory per week, second term.

Laboratory experiments and problems to illustrate subject 346.

348. Fluid Flow and Heat Transfer, W. D. Baines, C. H. Miller.

Course 8, III Year; Course 8, IV Year (1966–67 only); 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.

A study of the forces and motion produced by various fluid properties. Gravitational, viscous and inertial forces are considered in detail. Momentum, energy and continuity relation, boundary-layer approximation, turbulence, flow in pipes and around submerged bodies.

Conduction and convection in the steady state. Transient conduction phenomena. Dimensional analysis as applied to forced and free convection. Heat transfer with liquid metals. Radiation to and from real bodies. Combined heat transfer effects. Instrumentation and experimental methods.

350. Dynamics. G. E. Godfrey.

Course 1, II Year; 2 hrs. lectures per week, second term.

Motion of a point is reviewed and extended to include Coriolis' acceleration, with applications. Equations for motion of mass in translation, rotation, and plane motion are developed, including centre of percussion. An introduction to vector mechanics is given. Moment of inertia of mass is studied by double integration and by the lamina method. The derivation and application of gyroscopic action is thoroughly discussed, and an introduction to static and dynamic balancing is given. Elementary vibration theory and problems in vibration isolation are discussed.

Textbook: *Engineering Dynamics*—Hooper and Smith.

Reference book: *Mechanics*—Part II—Meriam; *Engineering Mechanics*, Vol. II, Vector Edition, Higdon & Stiles.

352. Dynamics. F. P. J. Rimrott.

Course 7, II Year; 2 hrs. lectures per week first term; 1 hr. lecture per week, second term.

Dimensional units; vectors; kinematics, rectilinear and angular motion, plane motion, projectiles, satellite orbits, rigid body concept, relative motion with respect to translating and to rotating vehicles; kinetics, force, d'Alembert's principle, rotation, translation, vibration of mechanical and electrical systems, work, energy, conservation of energy, power, impulse, momentum, rockets, jets, fluid mechanics, impact, balancing, centrifugal and Coriolis' force, critical speeds, gyroscopic effect.

Textbook: *Engineering Dynamics*—Hooper and Smith.

Reference book: Mechanics, Part II—Meriam.

353. Dynamics Laboratory.

Course 7, II Year; 1½ hrs. problems per week, both terms.

Problems in kinematics and kinetics to support subject 352.

355. Manufacturing Processes. R. T. Waines.

Course 3, II Year; 1 hr. lecture per week, first term.

Prior to registering in Second Year, the student is required to study the prescribed text, covering the topics of design materials and manufacturing methods and processes. The lecture work will involve discussion of the text matter, as well as new materials and processes.

Textbook: *Manufacturing Processes and Materials for Engineers*—Doyle, Morris, Leach and Schrader.

356. Design of Machine Elements. R. T. Waines.

Course 3, II Year; 2 hrs. lectures per week, second term.

Belts, shafts, bearings, brakes, clutches, couplings, spur and helical gears, power screws, fastenings, rivets, welding.

Textbook: *Mechanical Engineering Design*—Shigley.

357. Dynamics of Machines. D. L. Allen.

Course 3, II Year; 3 hrs. lectures per week, both terms.

Basic equations for accelerated motion of mass are developed and applied to the analysis of machine elements. Velocity, acceleration, force distribution, speed fluctuation and balancing of machines are considered. Standard linkages, cams, gears, flywheels, governors and gyroscopes are given specific attention.

Textbooks: *Engineering Dynamics*—Hooper and Smith. *Kinematics and Dynamics of Machinery*—Maxwell.

358. Mechanical Design Laboratory.

Course 3, II Year; 6 hours per week, both terms.

Problems in mechanical drawing, descriptive geometry, fits and tolerances, machine tool operations, dynamics of machines, metrology, and design of machine elements.

Textbook: *Engineering Drawing*—French and Vierck, 9th edition.

363. Machine Design. I. W. Smith, R. T. Hartlen.

Course 3, III Year; 2 hrs. lectures per week, first term.

Static and dynamic stress analysis, failure theory, deflections, experimental stress analysis, behaviour of engineering materials, single degree of freedom vibrations.

Textbooks: *Mechanical Engineering Design*—Shigley. *Vibration Theory and Applications*—Thomson.

Reference: *Experimental Stress Analysis and Motion Measurement*—Dove and Adams.

364. Machine Design Laboratory.

Course 3, III Year; 6 hrs. per week first term; 3 hrs. per week second term.

Design and stress analysis of machine elements; creative design; problems and experiments in applied mechanics.

365. Applied Elasticity. J. VandeVegte.

Courses 5nt, 5p, III Year; 1 hr. lecture per week, both terms.

Introduction (simple equations for normal and shear stresses; stress concentrations; fluctuating stresses and fatigue). Analysis of stress and strain in three dimensions, including use of primary and auxiliary Mohr's circles, and application to bending and torsion problems. Deflection analysis of statically determinate and indeterminate structures. Additional topics and applications include: Analysis of plates and shells, torsion of thin-walled tubes, stability of columns, thermal stresses.

366. Applied Elasticity Laboratory.

Courses 5nt, 5p, III Year; 3 hrs. laboratory per week, both terms.

Problems to support subject 365.

367. Machine Design. G. E. Godfrey.

Course 7, III Year; 2 hrs. per week, first term.

Force analysis; mechanics; velocities, accelerations and inertia forces in machines; principles of stress analysis and the design of various machine elements, including shafting, bearings, belts, gears, etc.; also an introduction to work on speed fluctuation, vibrations and balancing.

Textbook: *Mechanical Engineering Design*—Shigley.

368. Machine Design Laboratory.

Course 7, III Year; 3 hrs. per week, first term.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

371. Machine Design. R. L. Sakaguchi.

Courses 2, IV Year; 1 hr. lecture per week, both terms.

The design and selection of machinery and equipment met with in metallurgical plants, and in mining work.

Textbook: *Mechanical Engineering Design*—Shigley.

372. Machine Design Laboratory.

Course 2, IV Year; 3 hrs. laboratory per week, second term.

Problems worked out in the laboratory, designed to give the student training in the general lay-out of shafting and plant machinery, as well as in the design of simple parts for metallurgical apparatus, and mine machinery.

373. Machine Design. I. W. Smith.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

Although the design of some specific machine elements is covered, such as springs, ropes and curved frames, most of the course is concerned with design concepts, including organization, reliability and creativity. An introduction to the field of theoretical mechanics includes elasticity, plasticity, thermal stress, vibrating systems and advanced kinematics.

Textbooks: *Design of Machine Elements*—Spotts. *Vibration Theory and Application*—Thomson.

Reference Books: *Optimum Design of Mechanical Elements*—Johnson; *Theory of Elasticity*—Timoshenko.

374. Machine Design Laboratory.

Course 3, IV Year; 3 hrs. per week laboratory, first term; 4½ hrs. per week, second term.

Design and research projects utilizing the concepts given in

Subject 373 and emphasizing the creative approach. Seminars on new developments in the design field are held.

Work will be given in the Mechanical Laboratory on gauging and fine measurements, experimental stress analysis, vibration, and bearing testing.

375. Machine Design. G. E. Godfrey.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Force analysis; mechanics, velocities, accelerations and inertia forces in machine; stress analysis; deflections; failure theory; fluctuating stress, and design of various machine elements including shafts, bearings, belts, gears, riveted and welded parts, etc.; also an introduction to speed fluctuation and vibrations.

Textbook: *Design of Machine Elements* (third edition)—M. F. Spotts.

376. Machine Design Laboratory.

Course 4, IV Year; 3 hrs. per week, both terms.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

383. Mathematical Analysis. Staff in Mechanical Engineering.

Courses 3, 4 and 8, II Year; 1½ hrs. problems per week, both terms.

Solution of engineering problems by mathematical analysis, with particular reference to the work of subject 2420.

386. Engineering Analysis. Staff in Mechanical Engineering.

Course 3, III Year; 1½ hrs. problems per week, first term; 3 hrs. problems per week, second term.

Exercises in reducing physical problems to analytical statements, with emphasis on the formulation of differential equations, the solutions of the mathematical problems involved, and the physical interpretation of these solutions; assessment of the validity of mathematical models.

Reference books: *Engineering Analysis*—verPlanck and Teare; *Creative Engineering Analysis*—Ryder.

387. Treatment of Technical Data. L. E. Jones.

Course 3, III Year; 2 hrs. lectures per week, and 3 hrs. problems per week, second term.

Presentation of data; approximate nature of technical data; role played by mathematics; general numerical methods including FORTRAN computer language; methods of organizing data for computation; methods of analyzing technical data; elements of curve-fitting and statistical treatment.

390. Applied Mathematics in Engineering. L. E. Jones.

Course 3, IV Year; 1 hr. lecture per week, first term; 2 hrs.

lectures per week, second term; 3 hrs. problems per week, both terms.

Dimensional analysis and similarity, numerical methods, relaxation techniques, approximate solutions, digital and analogue computation, including FORTRAN computer programming, introduction to statistics and curve fitting.

391. Elementary Control Theory. J. VandeVegte.

Course 3, IV Year; 1 hr. lecture per week, both terms.

An introduction to the principles utilized in the analysis of linear control systems. Emphasis is also placed on the synthesis of mathematical models of simple systems, and the limitations inherently involved. Topics include stability criteria, characteristics of electrical, pneumatic and hydraulic control elements, and capabilities of feedback systems. A brief introduction to the problems arising from non-linear prototypes is included.

Recommended text: *Automatic Control Engineering*—Raven.

392. Elementary Control Theory Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, second term.

Problems and experiments related to subject 391.

393. Computational Methods. L. E. Jones.

Course 5nt, IV Year; 1 hr. lecture per week, 3 hrs. problems per week, both terms.

Practical extension of Subjects 2427 and 2428 to provide advanced computing experience with desk calculators and with analogue and digital computers. FORTRAN computer language will be studied in detail. Emphasis is placed on the economic use of available numerical procedures in the solution of engineering problems.

396. Industrial Management. B. M. M. Carpendale, P. B. Hughes.

Courses 3, 6, IV Year; 1 hr. lecture per week, first term.

Introduction to principles of management and organization.

Subjects 3440 and 396 are combined in one examination.

398. Control Systems. J. VandeVegte.

Course 5nt, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

A course in linear and non-linear control systems.

399. Control Systems Laboratory.

Course 5nt, IV Year; 3 hrs. laboratory per week, second term.

A laboratory course accompanying subject 398.

DEPARTMENT OF INDUSTRIAL ENGINEERING

401. Operations Research I. Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Methods of determining economic optima in industrial operations. Applications of mathematical techniques such as Lagrange

multipliers, linear programming, non-linear programming, dynamic programming, to problems in production scheduling and sequencing, inventory control, transportation, equipment investment, utilization of scarce resources, and so on.

Recommended text: *Concepts in Management Science*—Donald J. Clough, Prentice-Hall Inc.

402. Operations Research I Laboratory. Staff in Industrial Engineering.
Course 4, IV Year; 3 hrs. laboratory per week, both terms.
Practical work to accompany subject 401. Case studies and problem assignments.

403. Operations Research II. S. Kotz.
Course 4, IV Year; 2 hrs. lectures per week, second term.
Applications of probability theory and statistical analysis to problems in industrial operations. Markov theory applied to queuing, inventory, maintenance, and machine replacement problems. Statistical methods of estimation applied to the same problem areas.

404. Operations Research II Laboratory. S. Kotz.
Course 4, IV Year; 3 hrs. laboratory per week, second term.
Practical work to accompany subject 403. Case studies and problem assignments.

405. Dynamics of Industrial Systems. R. W. P. Anderson.
Course 4, IV Year; 2 hrs. lectures per week, first term.
The design and analysis of industrial systems, with particular emphasis on dynamic feedback models to simulate system behaviour. (Also see subject 406.)

406. Dynamics of Industrial Systems Laboratory. R. W. P. Anderson.
Course 4, IV Year; 3 hrs. laboratory per week, first term.
The M.I.T. Dynamo compiler is used in conjunction with the I.B.M. 7094 computer to simulate the dynamic behaviour of the systems dealt with in subject 405.

407. Elementary Control Theory. A. Porter.
Course 4, IV Year; 2 hrs. lecture per week, both terms.
The dynamic behaviour of simple linear mechanical and electrical networks; weighting functions and transfer functions of linear elements; the principles of analogue and digital computers; introduction to Boolean Algebra and its applications; elements of information theory and its control implications; introduction to linear servomechanisms and manually operated control systems.

408. Elementary Control Theory Laboratory. A. Porter.
Course 4, IV Year; 3 hrs. laboratory per week, both terms.
Problems and laboratory experiments related to subject 407.

409. Current Developments in Industrial Engineering. The Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lectures per week, second term.

A selection of topics emphasizing subjects of current technical interest in the field of Industrial Engineering. The interdisciplinary character of Industrial Engineering will guide the choice of specific treatment, perhaps from the fields of control theory, information theory, computer developments, management systems, biomedical problems, etc.

410. Current Developments Laboratory. The Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. laboratory per week, second term.

Readings in the topics of course 409 from the current technical literature will be assigned and two short essays will be required of each student.

411. Industrial Engineering Seminar.

Course 4, IV Year; 2 hrs. laboratory per week, first term.

Invited speakers, prominent in the Academic, Governmental, and Business communities, will conduct a series of talks followed by general discussion. An essay based on one of these sessions will be required.

414. Elements of Industrial Engineering. T. C. Graham, A. Porter.

Course 4, II Year; 2 hrs. lectures per week, both terms.

A broad survey of both old and new elements of Industrial Engineering, with selected reading and essay assignments, including work study, wage determination, controls of production, quality and cost, mathematical models of production and distribution systems, computer simulation techniques, operations research, human factors studies, and management science.

415. Human Factors Engineering I. A. Porter and others.

Course 4, III Year; 2 hrs. lecture per week, second term (commencing in the session 1967–68).

Human sensory capabilities (psychophysics), including visual and auditory systems and the muscular system in particular. This subject provides a foundation for the study of man-machine interactions in Human Factors Engineering II.

Textbooks: *Selected Papers on Human Factors in the Design and Analysis of Control Systems*—H. Wallace (ed.); Dover. *Human Engineering Guide to Equipment Design*—Morgan, Cook, Chaponis and Lurd; McGraw-Hill.

Reference Books: *Psychological Principles in System Development*—Robert M. Gagne, et al; Holt, Rinehart, Winston. *Research Techniques in Human Engineering*—A. Chaponis; Johns Hopkins. *Biotechnology: Concepts and Applications*—L. J. Fogel; Prentice-Hall. Selected papers from the Human Factors Journal, and other sources.

416. Human Factors Engineering II. E. L. Thomas and others.

Course 4, IV Year; 2 hrs. lecture per week, both terms (commencing in the session 1968–69).

An extension of the third year subject, Human Factors Engineering I, with emphasis on the human factors involved in the design of man-machine control systems. Some aspects of product design will also be discussed.

Textbooks and Reference Books are the same as those listed for Human Factors Engineering I.

417. Industrial Engineering Seminar.

Course 4, IV Year; 2 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Members of the staff in Industrial Engineering, and invited speakers prominent in the Academic, Governmental, and Business communities, will conduct a series of talks followed by general discussion. Two essays, on one or more of the subjects discussed, will be required.

418. Management Science. D. J. Clough.

Course 4, IV Year; 2 hrs. lecture per week, both terms (commencing in the session 1968–69).

Theories and methods of analysis to optimize product mix, process selection, equipment investment, production and distribution activity levels, competitive strategies, information flow and processing, organization, and control. Assessment of the accuracy, precision, and relevance of demand, cost, and technological data used in analyses, as obtained from designed industrial experiments, sampling, sample surveys, correlation of uncontrolled variables, and various internal and external agencies. Prerequisited are probability and statistics, linear algebra, and elementary differential equations.

Textbook: *Concepts in Management Science*—Donald Clough; Prentice-Hall.

419. Operations Research. Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lecture per week, and 3 hrs. laboratory per week, first term; 4 hrs. lecture per week, and 3 hrs. laboratory per week, second term (commencing in the session 1968–69).

Mathematical methods of operations research. Lagrange multiplier methods, linear and non-linear programming, dynamic programming, with assigned problems in production scheduling and sequencing, inventory control, transportation, machine replacement, and resource allocation. Systems of linear differential equations, complex variable theory, Markov theory, applied to queueing, inventory, maintenance, reliability, replacement, and information processing problems. Prerequisites are probability and statistics, linear algebra, and elementary differential equations.

A term test will be given at mid-session which will contribute 33% of the total course mark.

420. Systems Theories. Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lectures and 3 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Theories of automata; information theory; organization systems theories; computer simulation models applied in the design and analysis of production and distribution systems and their concomitant control systems.

421. Thesis Project. Staff in Industrial Engineering.

Course 4, IV Year; 6 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Design and analysis of an engineering system to satisfy certain objectives and requirements (e.g. the production of a specific product). This project will provide the student with an opportunity to apply the knowledge and techniques of analysis acquired in all the other Industrial Engineering subjects. The work will be carried out under the supervision of staff members. Progress reports and a written thesis are required.

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

600. Chemistry. The Staff in Chemical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

Chemical theory, with industrial and engineering applications.

601. Chemical Laboratory. W. F. Graydon, A. M. Rozeiu.

Courses 1, 3, 4, 5, 6, 7, 8 and 9, I Year; 3 hrs. laboratory per week, both terms.

A laboratory course illustrating the fundamental laws of chemistry as dealt with in the lecture course, and providing an introduction to chemical analytical methods.

602. Chemistry. W. H. Burgess.

Course 5, I Year; 2 hrs. lectures per week, both terms.

Introductory physical chemistry: the gas laws, chemical equilibria, elementary solution chemistry, thermochemistry. Problems dealing with industrial and engineering applications.

607. Engineering Chemistry. W. H. Rapson, S. Sandler.

Courses 1, 3, and 4, II Year; 2 hrs. lectures per week, first term.

Corrosion and water-treatment; introduction to organic chemistry.

608. Physical Chemistry. R. W. Missen.

Course 5, II Year, 2 hrs. lectures per week, both terms.

The themes discussed are conservation, equilibrium and rate of

change in chemical systems. These are applied to topics in thermochemistry, phase equilibrium, reaction equilibrium, including reactions in cells, and reaction kinetics.

Reference books: *Physical Chemistry*, by F. Daniels and R. A. Alberty, 2nd ed.; *Physical Chemistry*, by W. J. Moore, 3rd ed.

609. Physical Chemistry Laboratory. R. W. Missen.

Course 5, II Year, 3 hrs. laboratory, alternate weeks, both terms.

Experimental work and problems periods to accompany subject 608. In each term, each student performs a laboratory investigation of an individual problem of a research type; alternate periods are devoted to solving assigned problems.

610. Chemical Engineering Science Laboratory. Staff in Chemical Engineering.

Course 5, II Year (elective); 3 hrs. laboratory per week, second term.

An experimental introduction to physical rate processes. Electrical, fluid flow, heat transfer, and mass transfer systems with varied capacities are used to illustrate the dependence of the rate of transfer on driving force, resistance, etc.

Three laboratory reports.

613. Analytical Chemistry Laboratory. I. H. Spinner, M. E. Charles, J. Binkiewicz.

Course 6, II Year.

This course commences on the Wednesday following the first Monday in September, and continues until the opening of the Fall Term. All the working time will be spent on systematic quantitative inorganic analysis and machine computation of complex equilibria.

Textbook: *Textbook of Inorganic Analysis*—Kolthoff and Sandell.

614. Analytical Chemistry Laboratory. I. H. Spinner, J. Binkiewicz, C. P. Brockett.

Course 6, II Year; 9 hrs. laboratory per week, first term.

A continuation of Subject 613.

615. Analytical Chemistry. I. H. Spinner.

Course 6, II Year; 2 hrs. lectures per week, first term.

Equilibrium considerations in quantitative analysis.

617. Inorganic Chemistry. R. E. Jervis, H. D. Sharma.

Courses 6, 8 and 9, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

The constitution of matter and classification of the elements: systematic inorganic chemistry.

619. Chemical Engineering Science Laboratory. I. H. Spinner, C. P. Brockett, R. L. Hummel, J. W. Smith.

Course 6, II Year; 7½ hrs. laboratory per week, second term.
Experiments illustrating the kinetic and equilibrium principles of chemical engineering. Mass and heat balance calculations.
One laboratory report per week.

620. Process Calculations. J. W. Smith, I. H. Spinner.
Course 6, II Year; 3 hrs. laboratory per week, both terms.
Process calculations in chemical engineering.
Textbook: *Basic Principles and Calculations in Chemical Engineering*—Himmelblau.

625. Reaction Kinetics. W. H. Burgess.
Course 6, III Year; 1 hr. lecture per week, both terms.
Chemical kinetics; principles of adsorption and colloid chemistry.

627. Chemical Laboratory. W. F. Graydon, Z. May.
Course 6, III Year; 6 hrs. laboratory per week, both terms.
A laboratory course to accompany subject 640.
One laboratory report.

628. Organic Chemistry. J. G. Breckenridge.
Course 6, III Year; 2 hrs. lectures per week, both terms.
A continuation of subject 618, dealing mainly with aromatic compounds.

629. Organic Chemistry Laboratory. W. H. Rapson, Z. May.
Course 6, III Year; 9 hrs. laboratory per week, first term; 6 hrs. laboratory per week, second term.
A laboratory course accompanying subject 628.

630. Industrial Chemistry. W. G. MacElhinney, W. H. Rapson.
Course 6, III Year; 3 hrs. lectures per week, second term.
Chemical process industries, including petroleum, soap, sugar, pulp and paper, and fermentation industries. In preparation for this course, students will be expected to have read and to be thoroughly familiar with the following: Chemical Process Industries—Shreve: Chapters 29, 30, 31, 33, 34, 37.

631. Introduction to Mass and Heat Transfer. W. G. MacElhinney.
Course 6, II Year; 2 hrs. lectures per week, both terms.
Course 6, III Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.
The fundamental theory and practice used in transfer operations in chemical engineering. Energy and mass transfer are considered in the study of the flow of fluids, fluidization of solids, heat transfer, and evaporation of solutions.
Textbook: *Principles of Unit Operation*—Foust, Wenzel, Clump, Maus, and Andersen.

633. Applied Mathematics in Chemical Engineering. I. H. Spinner, R. W. Missen.

Course 6, III Year; 1 hr. lecture and 1 hr. problem period per week, both terms.

The first term is devoted to analysis and solution of chemical engineering problems which require knowledge of the rational design of experiments, treatment of experimental data and tests of hypotheses. The second term is devoted to applications of differential equations to problems of chemical engineering interest; emphasis is on the formulation of differential equations, together with their solution by analytical and numerical methods.

Reference Books: *Probability and Statistics for Engineers*—I. Miller and J. E. Freund. *Engineering Statistics*—A. H. Bowker and G. J. Lieberman. *Applied Differential Equations*—M. R. Spiegel.

640. Chemical Engineering Thermodynamics. W. F. Graydon.

Courses 5c and 6, III Year; 2 hrs. lectures per week, both terms.

A course in classical thermodynamics with problems in the field of applied chemistry and chemical engineering. Special emphasis is placed on chemical processes and compositional changes.

641. Chemical Engineering Rate Processes. O. Trass.

Course 5c, III Year; 2 hrs. lectures per week, both terms.

The kinetic theory of gases. Mechanisms and rates of homogeneous chemical reactions. Physical transport mechanisms and estimation of transport properties. Application to reaction kinetics and momentum, heat, and mass transfer.

642. Chemical Engineering Problems and Laboratory. Staff in Chemical Engineering.

Course 5c, III Year; 9 hrs. per week, first term; 7½ hrs. per week, second term. Problems and laboratory experiments illustrating topics discussed in Subjects 640 and 641.

650. Mass Transfer Operations. O. Trass.

Courses 5c and 6, IV Year; 2 hrs. lectures per week, both terms.

The theory and practice of mass transfer operations in chemical engineering are discussed. Many problems in distillation, extraction, absorption, and other operations illustrate the course.

Textbook: *Mass Transfer Operations*—R. E. Treybal.

651. Chemical Plant Design. R. W. Missen, J. W. Smith, M. Wayman.

Course 6, IV Year; 2 hrs. lectures and 6 hrs. laboratory per week, first term.

The lectures deal with selected topics in plant design: process design, plant location, economics. In the second term, process design calculations are done for a particular plant, ending with an economic evaluation of the process. If possible, a visit is made to a nearby operating plant to illustrate the work done in the laboratory.

Textbook: *Chemical Engineering Plant Design*—Vilbrandt and Dryden.

Reference book: *Chemical Engineering Cost Estimation*—Aries and Newton.

652. Chemical Engineering Laboratory. R. L. Hummel, W. G. MacElhinney, J. W. Smith, O. Trass.

Courses 5c and 6, IV Year; 9 hrs. laboratory per week, first term.

A laboratory course to accompany subjects 631, 650, and 651. Bench and pilot plant experiments are carried out to study a variety of unit operations such as fluidization, heat transfer, evaporation, filtration, distillation, extraction, and absorption. Modern control instruments are discussed and operated.

One laboratory report per week.

653. Applied Mathematics in Chemical Engineering. D. Basmadjian.

Course 6, IV Year; 3 hrs. laboratory per week, second term.

A problems course dealing with selected topics in dimensional, graphical and numerical methods, statistics and differential equations.

Reference books: *Applied Statistics for Engineers*—Volk; *Applied Mathematics in Chemical Engineering*—Mickley, Sherwood and Reed; *Nomography and Empirical Equations*—Davis.

654. Organic Chemistry. W. H. Rapson.

Course 6, IV Year; 2 hrs. lectures per week, second term.

The chemistry of natural and synthetic high-molecular-weight materials.

655. Chemical Engineering Thermodynamics and Kinetics. W. H. Burgess, W. F. Graydon.

Course 6, IV Year; 2 hrs. lectures per week, both terms.

The application of thermodynamics and kinetics to problems in the field of chemical engineering.

660. Organic Chemistry. J. G. Breckenridge, I. H. Spinner.

Course 5c, IV Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

A lecture course in organic chemistry, concluding with a section on the chemistry of high polymers.

661. Organic Chemistry Laboratory. Z. May.

Course 5c, IV Year; 6 hrs. laboratory per week, second term.

A laboratory course to accompany subject 660.

663. Instrumental Methods. S. Sandler.

Course 5c, IV Year; 2 hrs. lectures per week, second term.

The subject is designed to emphasize the science of chemical instrumentation. The principles, technique, and applications of gas-chromatographic, opticometric, electrometric, and mass-spectrometric methods of analysis are studied.

664. Process Dynamics. R. Luus.

Course 5c, IV Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.

Analysis and control of chemical engineering systems with emphasis on non-linear methods; phase plane; Liapunov's method; averaging technique.

Introduction to optimal control of processes; extraction train, distillation column, and chemical reactors.

665. Thermodynamics and Statistical Thermodynamics of Chemical Systems. R. W. Missen.

Course 5c, IV Year, 3 hrs. lectures per week, first term.

Development of the principles of chemical equilibrium and of statistical mechanics; application to both non-reacting and reacting systems, with emphasis on behaviour of multicomponent mixtures and complex reactions, and the calculation of thermodynamic properties in the ideal-gas state.

Reference books: *The Principles of Chemical Equilibrium*, by K. G. Denbigh; *Introduction to Statistical Mechanics*, by G. S. Rushbrooke.

666. Chemical Engineering Design. M. E. Charles and Staff in Chemical Engineering.

Course 5c, IV Year; 2 hrs. lectures and 6 hrs. laboratory per week, both terms.

Applications of heat transfer and fluid flow, process economics, optimal design, and applied mathematics in chemicals engineering, chemical plant design. In the first term the laboratory is devoted to problems in these topics and in those of Subject 665; in the second term process design calculations and an economic evaluation are done for a particular chemical plant.

Reference books: *Plant Design and Economics for Chemical Engineers*—Peters. *Applied Mathematics in Chemical Engineering* —Mickley, Sherwood, and Reed. *Chemical Engineer's Handbook* —Perry.

667. Dynamics of Chemical Systems. I. H. Spinner.

Course 5c, IV Year; 3 hrs. lectures per week, second term.

Elements of chemical rate process, complex chemical system dynamics, chemical reactor stability. Application of analogue computers to the solution of problems in above topics.

670. Nuclear Engineering. D. G. Andrews, R. E. Jervis.

Course 5nt, IV Year; 2 hrs. lectures per week, both terms.

Nuclear engineering aspects of: nuclear constitution and properties including cross-section, energetics, radioactivity, production and use of radio-isotopes, neutrons, slowing down, "age" theory, diffusion of thermal neutrons, fission.

The age and two-group theories of the reactor core. Reflected

reactors (elementary treatment). Reactor kinetics, control and instrumentation.

Applications of heat transfer, fluid flow and stress analysis to the reactor core.

The measurement and control of radiation. Exposure of humans to radiation. Shielding techniques.

Nuclear engineering applications of nuclear and radio-chemistry.

671. Nuclear Engineering Laboratory. D. G. Andrews, R. E. Jervis.

Course 5nt, IV Year; 3 hrs. laboratory per week, both terms.

A laboratory course to accompany subject 670.

Experiments are carried out with radiation sources and instruments, a sub-critical reactor, a reactor simulator, pulse height analyzers, fast neutrons generators and radioactive tracers.

DEPARTMENT OF ELECTRICAL ENGINEERING

700. Electricity. Staff in Electrical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

A basic course in electricity and magnetism including electric forces and fields, analysis of direct-current circuits, magnetic forces and fields, induction, and an introduction to the conductive, magnetic and dielectric properties of materials.

701. Electricity. Staff in Electrical Engineering.

Course 5, I Year; 2 hrs. lectures per week, both terms.

A basic course in electricity and magnetism that is similar to subject 700 but adapted to the needs of Course 5.

710. Circuit Theory I. A. J. Kravetz.

Course 7, II Year; 3 hrs. lectures per week both terms; 2 hrs. computation, alterate weeks, both terms.

The relation of lumped parameters to field concepts, their physical realization and their variation with frequency. The representation of simple systems by lumped parameter circuits.

The analysis of linear circuits in the steady state with either direct or alternating sources. Loop and nodal methods. The elements of the topography of circuits. Coupled circuits. Response of circuits to variable frequency.

The transient response of simple linear circuits to suddenly applied sources and its relation to the steady state.

Three-phase circuits, balanced and unbalanced. Other polyphase circuits.

General network theorems, rigorously derived, including the transformation theorems.

711. Electric and Magnetic Fields. S. D. T. Robertson.

Course 7, II Year; 2 hrs. lectures per week, both terms; 2 hrs. computation, alternate weeks, both terms.

Electric and magnetic fields, forces and energies associated with

charged and current-carrying conductors embedded in dielectric and magnetic media. Particle dynamics in electric and magnetic fields. Time-varying fields in conductors and insulators. Development of Maxwell's equations and interpretation in static and dynamic situations.

712. Electrical Measurements. H. A. Courtice.

Course 7, II Year; 2 hrs. lectures per week, second term.

Measurement of electrical quantities such as charge, potential difference, current, magnetic flux, energy and power. Measurement of electrical properties such as dielectric constant, permeability and conductivity. Measurement of resistance, inductance and capacitance. Transducers for electrical measurement of mechanical, thermal and other physical quantities. Measurement of alternating-current quantities in single-phase and polyphase systems. Accuracy of measurement, curve fitting and treatment of measured data.

713. Electrical Laboratory.

Course 3, II Year; 3 hrs. laboratory per week, first term.

Course 7, II Year; 3 hrs. laboratory per week, both terms.

Appropriate laboratory experiments to accompany subjects 710, 712, and 714.

Course 3. Six laboratory reports.

Course 7. Ten laboratory reports.

714. Electricity. H. A. Courtice.

Course 3, II Year; 2 hrs. lectures per week, first term.

General principles and calculations of electrical circuits, particularly as applied to the measurement of resistance, current, potential difference, inductance, capacitance, power, and energy. The principles underlying commercial instruments are considered, together with the methods of calibration.

715. Electric Circuits. V. G. Smith.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Circuits as models for physical devices. Kirchhoff's laws. Transient response of circuits. Steady-state response of circuits with sinusoidal excitation. Network theorems. Topology and loop and nodal analysis of general circuits. Complex frequency analysis of circuits. Response of circuits to variable-frequency excitation. Analysis of polyphase circuits. Magnetically coupled circuits.

716. Electric Circuits Laboratory.

Course 5, II Year; 3 hrs. laboratory alternate weeks, both terms.

Laboratory exercises to accompany subject 715.

Ten laboratory reports.

717. Alternating-Current Circuits. W. Janischewskyj, I. McCausland.

Courses 1 and 9, II Year; 2 hrs. lectures per week, first term.

Course 3, II Year; 2 hrs. lectures per week, second term.

Fundamentals of alternating current, voltage and power. The analysis of series, parallel and three-phase circuits containing resistance, inductance and capacitance.

718. Alternating-Current Circuit Laboratory.

Courses 1 and 9, II Year; 3 hrs. laboratory alternate weeks, first term.

Course 3, II Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory exercises to accompany subject 717.

719. Electrical Engineering. S. D. T. Robertson, H. O'Beirne.

Course 4, 6 and 8, II Year; 2 hrs. lectures per week, both terms.

Analysis of single-phase and three-phase circuits; principles of a-c and d-c machines; introduction to vacuum-tube and solid-state devices; basics of digital computation and analogue simulation; electronic measurements applied to industrial processes.

720. Electrical Laboratory.

Courses 4, 6 and 8, II Year; 3 hrs. laboratory per week, both terms.

Laboratory experiments and problems to accompany subject 719. Ten laboratory reports.

721. Programming and Numerical Methods. E. S. Lee.

Course 7, II Year; 1 hr. lecture and problems per week, both terms.

Fortran and other programming methods. Numerical differentiation, integration and solution of differential equations. Computational algorithms.

730. Physical Electronics. R. C. Cobbold.

Course 7, III Year; 2 hrs. lectures per week, both terms.

Introduction to solid-state physics and the theory of electron devices. Modelling and simple applications.

732. Applied Mathematics. P. P. Biringer.

Course 7, III Year; 2 hrs. lectures per week, both terms; 2 hrs. computation per week, both terms.

Vector analysis; functions of a complex variable, with applications to conformal mapping. Elementary probability theory and statistics.

733. Circuit Theory II. A. J. Kravetz.

Course 7, III Year; 3 hrs. lectures per week, first term, 2 hrs. lectures per week, second term.

Fourier series and integrals. Fourier and Laplace transforms. Operational methods applied to transients in linear systems. Network functions. Matrix techniques in network analysis. Two-port networks. Symmetrical components. Conventional filter design. Modern filter networks.

734. Electric Machinery I. G. R. Slemon.

Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Processes for the electromechanical conversion of energy; properties of ferromagnetic materials; modelling of magnetic devices and systems; transformers and saturable reactors; commutator machines; an introduction to the control of electrical machines.

735. Electrical Laboratory.

Course 7, III Year; 3 hrs. laboratory per week, both terms. Laboratory exercises to accompany subjects 733 and 734.

736. Electrical Problems and Seminar.

Course 7, III Year; 4 hrs. laboratory per week, both terms.

Problems associated with courses 730, 733, 734 and 737, worked out under staff supervision. To provide practice in technical public speaking, one hour per week in the first term is set aside to allow for a short talk by each student on a topic of his own choice.

737. Electronic Circuits I. J. E. Reid.

Course 7, III Year; 2 hrs. lectures per week, second term.

Application of electron devices in amplification and signal processing.

738. Electronics Laboratory.

Courses 5a, 5e, 5p and 7, III Year; 3 hrs. laboratory per week, second term.

Laboratory experiments to accompany subjects 730, 737 and 739.

Five laboratory reports.

739. Physical Electronics. S. Dmitrevsky.

Courses 5a, 5e, 5p, III Year; Course 5m, IV Year; 2 hrs. lectures per week, both terms.

A subject similar in content of that of 730 but adapted to the needs of Course 5.

740. Electronics. I. R. Dalton.

Courses 5c, 5g, III Year; 2 hrs. lectures per week, both terms.

Qualitative treatment of the physical principles of electron devices; analysis of idealized and basic practical rectifying and power-modulating circuits; some applications to systems.

741. Electronics Laboratory.

Courses 5c, 5g, III Year; 3 hrs. laboratory alternate weeks, second term. Laboratory experiments to accompany subject 740.

Five laboratory reports.

742. Circuit Analysis. J. L. Yen.

Course 5e, III Year; 2 hrs. lectures per week, both terms.

Advanced analytical methods are used to derive general network theorems and to discuss general network properties. Com-

plex wave forms, filters and unbalanced polyphase networks are considered in detail.

743. Electronics. P. E. Burke.

Courses 3 and 4, III Year; 2 hrs. lectures per week, first term.

Properties of vacuum tubes, gas tubes and semiconductors and their use as rectifiers and modulating devices. The use of circuit models in analysing the behaviour of electronic devices.

744. Electronics Laboratory.

Courses 3 and 4, III Year; 3 hrs. laboratory alternate weeks, first term.

Laboratory experiments to accompany subject 743.

Four laboratory reports.

745. Energy Conversion Processes.

Course 5e, IV Year; 2 lectures per week, both terms.

Energy conversion phenomena, magnetic materials, modelling and analysis of magnetic devices including transformers, commutator and polyphase machines, solid-state converters. Electromagnetic force and fluid interactions.

746. Energy Conversion Laboratory.

Course 5e, IV Year; 3 hrs. laboratory alternate weeks, both terms.

Investigations and projects related to subject 745.

747. Electric Machines. A. Straughen.

Course 3, III Year; 2 hrs. lectures per week, both terms.

Operating characteristics, control, and applications of direct-current and alternating-current machines, and transformers.

748. Electric Machines Laboratory.

Course 3, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.

Laboratory exercises to accompany subject 747.

Five laboratory reports.

760. Electric Machines. W. Janischewskyj.

Course 4, IV Year; 2 hrs. lectures per week, first term.

Operating characteristics and applications of transformers and rotating electric machines.

761. Electric Machines Laboratory.

Course 4, IV Year; 3 hrs. laboratory per week, first term.

Laboratory exercises to accompany subject 760.

Four laboratory reports.

762. Electromagnetic Engineering. G. Sinclair.

Course 7, IV Year; 2 hrs. lectures per week, both terms; 2 hrs. computation alternate weeks, both terms.

Maxwell's equations, wave equations, retarded potentials, reciprocity theorem, lumped and distributed circuits, transmission

lines under transient and steady-state conditions, impedance charts, matching, waves in rectangular and circular waveguides, radiation from linear antennas, arrays, Friis transmission formula.

763. Electric Machinery II. G. R. Slemon.
Course 7, IV Year; 2 hrs. lectures per week, first term.
The structure, field analysis and modelling of generalized polyphase machines; induction and synchronous machines; behaviour under unbalanced conditions; single-phase machines and alternating current control motors.

764. Electric Machines Laboratory.
Course 7, IV Year; 3 hrs. laboratory per week, first term.
Laboratory exercises to accompany subject 763.
Four laboratory reports.

765. Control Systems. H. W. Smith.
Course 7, IV Year; 2 hrs. lectures per week, both terms.
A study of the analysis and synthesis of linear feedback control systems by means of differential equations and the Laplace transform. Topics covered include stability criteria, root-locus methods and compensation methods. An introductory study of non-linear systems is also made, including the use of describing-function and phase-plane methods of analysis.

766. System Dynamics. I. McCausland.
Course 5e, IV Year; 2 hrs. lectures per week, both terms.
A course in linear and non-linear control systems that is similar to subject 765 but adapated to the needs of Course 5e.

767. System Dynamics and Control Systems Laboratory.
Courses 5e and 7, IV Year; 3 hrs. laboratory alternate weeks, both terms.
Laboratory experiments to accompany subjects 765 and 766.
Four laboratory reports.

768. Electronic Circuits II. J. E. Reid.
Course 7, IV Year; 3 hrs. lectures per week, first term.
Application of electron devices in power amplification, detection, modulation, pulse shaping, etc.

769. Electronic Circuits Laboratory.
Courses 5a, 5e, 5p and 7, IV Year; 3 hrs. laboratory per week, first term.
Experiments and problems to accompany subjects 768 and 778.
Six laboratory reports.

770. Communication Systems. G. R. Lang.
Course 7, IV Year; 3 hrs. lectures per week, second term.
An introduction to the analysis and design of systems for transmitting information.

771. Communications Laboratory.
Course 7, IV Year; 3 hrs. laboratory per week, second term.
Experiments and problems to accompany subjects 770 and 782.
Seven laboratory reports.

774. Electric Machinery III. G. R. Slemon.
Course 7, IV Year; 2 hrs. lectures per week, second term.
Nonlinear power modulators, transient performance of induction and synchronous machines; reluctance, commutator and control machines.

775. Electric Machines Laboratory.
Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.
Laboratory exercises to accompany subject 774.
Three laboratory reports.

776. Microwave Engineering. N. C. McDermott.
Course 7, IV Year; 2 hrs. lectures per week, second term.
Basic field theory, Maxwell's equations, waves and modes in rectangular waveguides. Generation, coupling, transmission and detection of microwave energy. Resonant cavities, waveguide components and their uses.

777. Microwave Engineering Laboratory.
Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.
Laboratory experiments to accompany subject 776.

778. Electronic Circuits. G. Dick.
Courses 5a, 5e, 5p, IV Year; 3 hrs. lectures per week, first term.
A course similar to subject 768 but adapted to the needs of Course 5.

779. Electric Power Systems. W. Janischewskyj.
Course 7, IV Year; 3 hrs. lectures per week, second term.
Engineering aspects of the economic generation, transmission and distribution of electrical energy in bulk and the control of power systems under normal and fault conditions.

780. Electric Power Systems Laboratory.
Course 7, IV Year; 3 hrs. laboratory exercises and problems per week, second term, to accompany subject 779.

781. Computer Logic and Design. E. S. Lee.
Course 7, IV Year; 1 hr. lecture per week, both terms.
An introduction to the logical structure and electronic circuits of digital computers.

782. Information Systems. G. Lang.
Course 5e, IV Year; 2 hrs. lectures per week, first term; 3 hrs. lectures per week, second term.

The theory and application of switching systems and circuits, data transmission systems, information theory, analysis and design of information systems and components, noise.

783. Information Systems Laboratory.
Course 5e, IV Year; 3 hrs. laboratory per week, second term. Experiments and special project to accompany subject 782.

790. Wave Theory. G. Sinclair, V. L. Henderson.
Courses 5e, 5g, 5p, IV Year; 2 hrs. lectures per week, first term; 3 hrs. lectures per week, second term.
Mechanical and electromagnetic waves in one dimension for transient and steady state conditions. Guided waves. Radiation. Interaction of waves with matter.

791. Wave Laboratory.
Course 5e, IV Year; 3 hrs. per week, second term. Supplementing course number 790.

792. Acoustics. V. L. Henderson.
Course 7, IV Year; 2 hrs. lectures per week, second term.
The properties of acoustical elements and their application in electrical sound systems.

793. Acoustics Laboratory.
Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.
Supplementing subject 792.
Three laboratory reports.

794. Illumination. Miss M. G. Currie.
Course 7, IV Year; 2 hrs. lectures per week, second term.
Illuminating Engineering dealing with the nature, measurement and production of light and related radiations.
Theory of human vision; consideration of environmental design requirements related to light and vision for optimum visual efficiency and comfort.

795. Illumination Laboratory.
Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.
Supplementing subject 794.
Three laboratory reports.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

802. Chemistry of Metals. L. M. Pidgeon.
Courses 5m and 8, III Year; 2 hrs. lectures per week, first term.
A fundamental treatment of the metallurgical processes involved in the production of the important non-ferrous metals, including

oxidation of sulphides in the liquid and solid states, reduction of oxides, matte-slag equilibrium, metal-slag equilibrium, and the distillation of metals.

803. Chemistry of Metals Laboratory. H. U. Ross.
Course 8, III Year; 3 hrs. laboratory per week, first term; 6 continuous hrs. laboratory per week, second term.
Experiments in materials processing, including roasting, smelting, leaching, refining, electrolysis to accompany Subjects 802 and 833. Eight laboratory reports per term.

804. Metallurgy. H. U. Ross.
Course 9, III Year; 1 hr. lecture per week, second term.
An introductory course describing the theory and practice of metallurgical processes and operations.

805. Chemistry of Metals. L. M. Pidgeon, H. U. Ross.
Courses 5m and 8, IV Year; 2 hrs. lectures per week, both terms.
The extractive metallurgy of iron, steel, and the reactive metals.

806. Chemistry of Metals Laboratory. H. U. Ross.
Course 8, IV Year; 6 continuous hrs. laboratory per week, first term.
Experiments in the extraction and refining of metals and related processes to accompany Subject 805. Six laboratory reports per term.

808. Metallurgy. L. M. Pidgeon.
Courses 2 and 9, IV Year; 1 hr. lecture per week, both terms.
The extractive metallurgy of the common metals, together with the calculations necessary to understand metallurgical processes.

809. Metallurgy Laboratory. H. U. Ross.
Course 2, IV Year; 6 hrs. continuous laboratory per week for one half of second term.
Similar to subject 803.
One laboratory report per week.

810. Thermodynamics in Metallurgy. S. N. Flengas.
Course 8, III Year; 2 hrs. lectures per week, both terms.
A study of chemical equilibria at high temperatures in extractive metallurgy—slag metal reactions—classical theory of solutions—phase transformations—thermodynamic relationships in phase diagrams.

812. Metallurgical Problems Laboratory. S. N. Flengas, H. U. Ross.
Course 8, III Year; 4 hrs. laboratory per week, both terms.
Problems in chemistry, physical chemistry and thermodynamics as applied to metallurgical processes, and solid state reactions relating to Subjects 802 and 810.

813. Physical Chemistry of Materials. S. N. Flengas.

Course 8, IV Year; 2 hrs. lectures per week, both terms.

The physico-chemical principles of metallurgy—electro-chemical and thermodynamic properties of matter in the condensed states—thermodynamics of imperfections—quasi-chemical approach to the theory of solutions—properties of surfaces—kinetics of heterogeneous reactions—corrosion.

814. Metallurgical Problems Laboratory. S. N. Flengas.

Course 8, IV Year; 2 hrs. lectures per week, both terms.

Problems relating to subjects 805 and 813.

815. Physical Metallurgy. G. B. Craig, B. Ramaswami.

Course 1, II Year; Course 2, IV Year; 2 hrs. lectures per week, second term.

A course on the structure and mechanical properties of metals and alloys and on the influence of heat and mechanical treatment upon these properties. Reference is made particularly to steels and the more-important non-ferrous alloys. Welding of metals is also included.

816. Physics of Metals. B. Ramaswami.

Course 5c, IV Year; 1 hr. lecture per week, both terms.

A course on the physics of metals to include the structure of solids, defects in the solid state, diffusion, the effects of stress and temperature upon metals, and the relationship between structure and properties.

817. Physical Metallurgy. W. C. Winegard.

Course 3, II Year; 2 hrs. lectures per week, both terms.

A general course in Physical Metallurgy, dealing with the structure of metals and alloys, with special reference to the ferrous alloys of practical importance. The influence of mechanical deformation, heat treatment, and composition on the structure is considered, and the relation between the structure and mechanical properties is examined.

818. Physical Metallurgy Laboratory. W. C. Winegard.

Course 3, II Year; 3 hrs. laboratory per week for six weeks, second term.

A practical course illustrating the principles dealt with in subject 817. Experiments are conducted on the heat-treatment of ferrous and non-ferrous alloys.

819. Physics of Metals. J. R. Carruthers.

Courses 5e and 7, III Year; 2 hrs. lectures per week, second term.

A course on the physics of metals to include structure of solids, defect structures, diffusion, electron theory, phase transformations, and the effect of stress and temperature upon metals.

820. Physics of Metals Laboratory. J. R. Carruthers.
Course 7, III Year; 1½ hrs. laboratory per week, second term.
Experiments are conducted to illustrate the essential features of Subject 819. These include the examination of metals by metallographic and X-ray diffraction techniques.

821. Physics of Metals. G. B. Craig, B. Ramaswami.
Courses 5m, 8, III Year; 2 hrs. lectures per week, both terms.
A discussion of the structure of solids with particular reference to X-ray methods of investigation; the solidification of metals, and the plastic deformation of metals with reference to the dislocation theory.

822. Physics of Metals Laboratory. J. R. Carruthers.
Courses 5m and 8, III Year; 6 hrs. laboratory per week, first term; 3 hrs. laboratory per week, second term.
Practical work relating to Subject 821.

823. Physics of Metals. G. B. Craig, W. C. Winegard, B. Ramaswami.
Courses 5m and 8, IV Year; 3 hrs. lectures per week, both terms.
Transformations which occur in alloys, diffusion, electron theory, surface reactions.

824. Physics of Metals Laboratory. G. B. Craig.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms.
Practical work relating to Subject 823.

826. Materials Science Seminar. Staff in Metallurgy.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms.
Each student prepares and presents seminars on topics concerning chemistry and physics of materials.

827. Materials Science Laboratory. Staff in Metallurgy.
Course 5m, IV Year; 12 hrs. per week, both terms.
The design and execution of one or more experiments on a topic of current interest in the field of chemistry and physics of materials.

829. Chemistry of Metals Laboratory. H. U. Ross.
Course 5m, III Year; 3 hrs. per week, second term.
Experiments designed to illustrate the principles underlying the high temperature reactions which are encountered in the production and refining of metals.

830. Metallurgical Thermodynamics. S. N. Flengas.
Course 5m, III Year; 1 lecture per week, both terms.
Chemical equilibria at high temperatures in extractive metallurgy. Condensed states of matter—quasichemical approach to the theory of solutions—slag theories—metallic solutions—slag/metal equilibria—kinetics of metallurgical processes.

831. Metallurgical Thermodynamics Problems. S. N. Flengas.
Course 5m, III Year; 2 hrs. per week, both terms.
Problems relating to Subject 830.

832. Materials Science. Staff in Chemical Engineering, Civil Engineering, Electrical Engineering and Materials Science.
Course 8, II Year; Course 5m, III Year; 2 hrs. lectures per week, both terms.
Course 8, III Year (Session 1966–67 only); 2 hrs. lectures per week, both terms.
A course on the structure and properties of plastics, glass, ceramics, semi-conductors, and concrete.

833. Materials Processing II. H. U. Ross.
Course 8, III Year; 2 hrs. lectures per week, first term.
The theory and practice of processing metallic and non-metallic materials, including the relevant aspects of mineralogy, surface chemistry, physical separation, calcining, roasting, sintering and leaching.

834. Materials Science. G. B. Craig.
Course 4, II Year; 2 hrs. lectures per week, both terms and 3 hrs. laboratory per week, second term.
A discussion of the effects of microscopic and atomic structures on the electrical, chemical and mechanical properties of engineering materials. The topics covered will include atomic bondings, structures of ideal and real crystals, phase transformations and diffusion, chemical and mechanical properties, and oxidation and corrosion phenomena.
The laboratory experiments will include x-ray studies of crystal structure; measurement of resistivity and magnetism of selected solids; study of alloys through various phases and transformations; study of dislocation patterns, stress-strain relationships, stress-relaxation phenomena and fatigue phenomena; and study of oxidation and corrosion reactions.

INSTITUTE FOR AEROSPACE STUDIES

1028. Fluid Mechanics. H. S. Ribner.
Course 5a, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.
Introductory concepts; mathematical theory of inviscid flow, incompressible and compressible; viscous flow and turbulence.

1029. Fluid Mechanics Laboratory. H. S. Ribner, B. Etkin, S. J. Townsend.
Course 5a, III Year; 3 hrs. laboratory per week, first term; 3 hrs. laboratory alternate weeks, second term.
Problems and experiments related to subject 1028. Seven laboratory reports.

1030. Advanced Mechanics. S. J. Townsend.

Course 5, III Year; 2 hrs. lectures per week, both terms.

Mechanics of particles: fixed axes, rotating and moving axes, orbital dynamics, rockets. Mechanics of rigid bodies: fixed axes, body-attached axes, gyroscopes. Mechanics of linear systems: free and forced oscillations, coupled systems, waves on a string. Rayleigh's method. Lagrange's equations. Introduction to special relativity.

Reference books: *Introduction to Theoretical Physics*—Page. *Principles of Mechanics*—Synge and Griffith. *Dynamics*, Vols. I and II, Halfman.

1034. Mechanics of Structures. R. C. Tennyson.

Course 5a, III Year; 2 hrs. lectures per week, both terms.

Bending and torsion of thin web beams and shells. Analysis of indeterminate structures using energy theory. Instability of columns and plates. Plane stress problems; the Airy and Prandtl stress functions.

Reference books: *Aircraft Structural Mechanics*—Steinbacker and Gerard. *Elasticity in Engineering*—Sechler.

1035. Mechanics of Structures Laboratory. R. C. Tennyson.

Course 5a, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. per week, second term.

Problems and experiments relating to subject 1034. Five laboratory reports.

1040. Aerodynamics. B. Etkin.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Aerodynamics of flight: drag, propulsion, wing theory. Mechanics of flight: performance of aircraft, stability and control of aircraft.

Reference books: *Aerodynamics for Engineering Students*—Houghton and Brock. *Foundations of Aerodynamics*—Kuethe and Schetzer. *Flight Mechanics—1: Theory of Flight Paths*—A. Miele. *Dynamics of Flight—Stability and Control*—Etkin.

1041. Aerodynamics Laboratory. S. J. Townsend.

Course 5a, IV Year; 3 hrs. laboratory alternate weeks, both terms.

Problems and experiments related to subject 1040.

Five laboratory reports.

1043. Engineering Design. G. K. Korbacher.

Course 5a, IV Year; 4½ hrs. laboratory per week, both terms.

A number of multidisciplinary engineering design projects are carried out by the student under the supervision of staff and of experienced design engineers from industry. Drawings and reports are prepared as required.

1044. Physics and Mechanics of Solids. G. K. Korbacher.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Properties of solids, their dependence on atomic bonding, atomic and molecular structure. Structural imperfections and atom movements. Deformation and failure of metals. Multiphase materials and phase relationships. Modification of properties through microstructural changes. Environmental effects on service life. Physics of surface protection. Technology of non-destructive testing.

Reference books: *Elements of Materials Science*—Van Vlack. *Inelastic Behaviour of Engineering Materials and Structures*—Freudenthal.

1045. Mechanics of Solids and Structures Laboratory. G. K. Korbacher.

Course 5a, IV Year; 3 hrs. laboratory per week, both terms.

Problems and experiments related to subject 1044.

Six laboratory reports.

1046. Plasmadynamics. R. M. Measures.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Review of electric and magnetic fields. Derivation of Maxwell's equations. Thermodynamics and equations of motion of an electrically conductive medium. Simple examples of the influence of a magnetic field on the motion of an electrically conductive medium.

1047. Plasma Diagnostics Laboratory. R. M. Measures, S. J. Townsend.

Course 5a, IV Year; 3 hrs. laboratory alternate weeks, second term.

Problems and experiments based on the lecture material of subject 1046.

Two laboratory reports.

1048. Gasdynamics. P. A. Sullivan.

Course 5a, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

Introductory thermodynamics of perfect and imperfect gases; equations of motion and their applications to nozzles, diffusers, shock tubes, and shock tunnels; expansion waves and normal and oblique shock waves in perfect and imperfect gases; shock and expansion wave interactions.

Reference books: *Elements of Gasdynamics*—Liepmann and Roshko. *Dynamics and Thermodynamics of Compressible Fluid Flow*—Shapiro. *Handbook of Supersonic Aerodynamics, Section 18, Shock Tubes*—Glass and Hall.

1049. Gasdynamics Laboratory. P. A. Sullivan, S. J. Townsend.

Course 5a, IV Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.

Problems and experiments based on subject 1048 are given to illustrate principles of gasdynamics and the measurement of physical quantities.

Six laboratory reports.

1050. Transport Phenomena. J. B. French.

Course 5a, IV Year; 1 hr. lecture per week, both terms.

A fundamental treatment of selected phenomena in fluid dynamics in which the transport of momentum, mass and energy are the key underlying processes, i.e. dynamics of viscous fluids; boundary layers; diffusion.

Reference book: *Transport Phenomena*—Bird, Stewart and Lightfoot.

DEPARTMENT OF PHILOSOPHY

2040. Philosophy of Science. F. F. Wilson, G. Vise.

Courses 1, 2, 3, 4, 5, 6, 7, 8, and 9, IV Year; 2 hrs. lectures per week, first term.

The relation between Science and Philosophy; an examination of the presuppositions of science and its basic concepts; alternative accounts of the nature of the universe with their implications for social and moral behaviour.

DEPARTMENT OF ENGLISH

2110. English.

All courses, I Year; 2 hrs. lectures per week, both terms.

A course in essay writing and the reading of literary works. Texts will include: Swift, *Gulliver's Travels* (Modern Library College), Twain, *Huckleberry Finn* (Chandler), Fitzgerald, *Great Gatsby* (Scribner), Salinger, *Catcher in the Rye* (Bantam); Shakespeare, *King Lear* (Ginn), Jonson, *Volpone* (Yale), Synge, *Playboy of the Western World* in *Plays, Poems and Prose* (Dent), Miller, *Death of a Salesman* (Compass); a poetry anthology to be announced in September.

Students must complete satisfactorily all assignments, including class tests, given them by their instructor. It should be noted that the final mark for the year is the average of the term mark and the examination mark.

2140. English Literature.

All courses, IV Year; 1 hr. lecture per week, both terms.

A course in the drama, the novel and poetry based on the study of the following texts: Shakespeare, *Othello* (Methuen), Shaw, *Saint Joan* (Penguin), Brecht, *Galileo* (Methuen), Williams, *Streetcar Named Desire* (Signet); Lawrence, *Sons and Lovers* (Viking), Fitzgerald, *Great Gatsby* (Scribner), Golding, *Lord of the Flies* (Penguin), Oscar Williams, ed. *Immortal Poems of the English Language* (Washington Square).

Students are expected to read the works named above during the summer preceding their entry into the Fourth Year. Term work

will include assignments based on texts read during the summer, one substantial essay, and two class tests. Students who obtain a satisfactory term mark will not be required to write a final examination.

DEPARTMENT OF HISTORY

2330. Europe and the Modern World, 1500–1950. R. F. Harney.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An introduction to the main currents of European history between 1500 and 1950, and of European relations with the extra-European world. The purpose of the course is not merely the accumulation of factual information, but also the attainment of some understanding of historical processes affecting the forms of political organization, economic activity, intellectual and social movements.

Textbook: E. R. Tannenbaum, *European Civilization Since The Middle Ages* (John Wiley).

DEPARTMENT OF MATHEMATICS

2410. Algebra and Analytic Geometry. Staff in Mathematics and Staff in Engineering.

Courses 1, 3, 4, 6, 7, 8, 9, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

Introduction to linear algebra with applications to three dimensional euclidean geometry. Matrix algebra and the solution of linear systems of equations. Determinants. Reduction of quadrics to standard form.

2411. Calculus. Staff in Mathematics and Staff in Engineering.

Courses 1, 3, 4, 6, 7, 8, 9, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

The theory of the derivative. Applications to curve sketching, rate problems and extremal problems. The definite integral. Volume and work calculations. Techniques of integration.

2415. Algebra and Geometry. B. Bernholtz, Miss M. Wonenburger.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

Complex numbers and fields. Polynomials. Linear Algebra: linear equations, vector spaces and linear transformations. Coordinate Geometry: lines, planes and surfaces of the second degree.

2416. Calculus. W. J. R. Crosby, D. K. Sen.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

An introduction to the theory and applications of differential and integral calculus.

Reference books: *Calculus*—Sherwood and Taylor. *Calculus*, Vol. I—Apostol.

2420. Calculus. B. Brainerd, M. A. Abrglu, N. A. Duzko, H. Levenbach, K. A. Selby.

Courses 1, 3, 4, 6, 8 and 9, II Year; 2 hrs. lectures per week, both terms.

Continuation of subject 2410. Partial differentiation, multiple integration, series and Taylor's theorem, complex numbers and hyperboic functions, first order differential equations and higher order linear differential equations with constant coefficients. Problems dealt with in the drafting room as outlined in subjects 138, 143, 144 and 383.

2421. Calculus and Differential Equations. P. B. Griener.

Course 7, II Year; 2 hrs. lectures per week, both terms. 2 hrs. computation per week, both terms.

The definite integral, expansion in series, ordinary differential equations, partial differentiation, multiple integration and an introduction to partial differential equations.

2423. Probability and Statistics. L. Steinberg.

Courses 4 and 8, II Year; 2 hrs. lectures per week, both terms.

Frequency distributions and probability laws; binomial, Poisson, and normal distributions and the treatment of samples drawn from them; tests of significance and confidence limits; control charts; introduction to the analysis of variance; design of experiments; regression theory.

2424. Probability and Statistics Laboratory. L. Steinberg.

Courses 4 and 8, II Year; 2 hrs. laboratory per week, both terms.

Laboratory exercises associated with the material of the companion lecture subjects.

2425. Differential Calculus. D. K. Sen.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Ordinary and partial differentiation, differentials. Taylor's theorem for functions of one or more variables, maxima and minima, transformations, convergence and uniform convergence, differential equations of the first order, linear differential equations with constant coefficients.

Reference books: *Advanced Calculus*—Sokolnikoff. *Advanced Calculus*—Taylor.

2426. Integral Calculus. W. J. Webber, K. B. Ranger.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Methods of indefinite integration, definite integrals, multiple integrals, line and surface integrals, orthogonal functions.

Textbook: *Advanced Calculus*—Sokolnikoff.

2427. Probability and Statistics. R. Wormleighton.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Definition of probability; binomial, Poisson, and normal distributions; frequency; sampling distributions. Examples of estimation, hypothesis testing, control charts, regression, and analysis of variance.

2428. Mathematical Problems, and Machine Computation. W. J. R. Crosby, D. K. Sen, W. J. Webber, R. Wormleighton.

Course 5, II Year; 3 hrs. problems per week, both terms.

A laboratory course: uses weekly problems based on the content of courses 2425, 2426, 2427 and provides an opportunity for informal discussion of topics presented in these courses. A portion of the time will be devoted to machine calculation.

2429. Numerical Methods. T. E. Hull.

Course 5, II Year; 1 hr. lecture per week, first term; 1 hr. lecture and 3 hrs. laboratory per week, second term.

Non-linear equations, matrix calculations, quadrature, and ordinary differential equations.

2430. Probability and Statistics. L. Chan.

Course 4, III Year; 1 lecture per week, both terms.

A continuation of course 2423.

General regression theory; elements of the theory of sample surveys; an introduction to the theory of stochastic processes.

2431. Probability and Statistics Laboratory. L. Chan.

Course 4, III Year; 1½ hrs. per week, both terms.

Laboratory exercises based on the material of course 2430.

2432. Differential Equations. C. Billigheimer, W. Selander.

Courses 3, 4, 8, 9, III Year; 2 hrs. lectures per week, both terms.

First and second order ordinary differential equations, operational methods, variation of parameters, solution in series, Fourier series, Bessel and Legendre functions, the Laplace transform.

2433. Numerical Analysis.

Course 4, III Year; 2 hrs. lectures per week, both terms.

Solution of algebraic equations, systems of linear equations, eigenvalue problems, interpolation, approximation theory, numerical integration, random numbers.

Reference texts: *An introduction to Numerical Mathematics*—E. L. Stiefel. *Methods in Numerical Analysis*—Kaj L. Nielsen. *Numerical Methods for Science and Engineering*—R. G. Stanton.

2434. Numerical Analysis Laboratory. N. Stewart.

Course 4, III Year; 3 hrs. laboratory per week, both terms.

Practice in the numerical analysis methods and techniques dealt with in the lecture subject. Practical problems, as well as problems of a fundamental mathematical nature, will be covered.

2437. Theory of Functions. W. H. Greub.

Course 5, III Year; 2 hrs. lectures per week, both terms.

Complex numbers, limits and series, analytic functions, Cauchy's theorem, Taylor and Laurent series, singularities and their significance, analytic continuation, contour integration, conformal mapping of one plane region on another.

Textbooks: *Functions of a Complex Variable*—Phillips. *Theory of Functions*—Copson. *Theory of Functions as Applied to Engineering Problems*—Rothe, Ollendorf, and Pohlhausen. *Introduction to Complex Variables and Applications*—Churchill.

2438. Differential Equations. D. K. Sen.

Course 5, III Year; 2 hrs. lectures per week, both terms.

First order equations solvable by quadratures, the linear equation of general order, operator methods, simultaneous linear equations, Sturm-Liouville systems, numerical methods.

Textbook: *Ordinary Differential Equations*—Kaplan.

2445. Differential Equations of Mathematical Physics. G. F. D. Duff.

Courses 5a, 5e, 5g, 5m, 5n, 5p, 5t, IV Year; 2 hrs. lectures per week, both terms.

The underlying theory and important particular equations, including eigenvalues and eigenfunctions, Fourier integrals, spherical and cylindrical harmonics, vibration of strings, membranes, and rods, sound waves, equation of heat conduction.

Textbook: *Partial Differential Equations of Mathematical Physics*—Webster.

DEPARTMENT OF PHYSICS

2501. The Structure and Properties of Matter. J. N. P. Hume, R. J. Balcombe, M. Fowler, J. Perz, B. P. Stoicheff.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

An introduction to the mechanical, electrical, magnetic, thermal and optical properties of matter in terms of atoms.

2502. Physics Laboratory. The Staff in Physics, Civil Engineering and Electrical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year.

Twenty-four 3-hour periods of laboratory or problem work, twelve of which are devoted to experiments in the Physics Laboratory, six to experiments in the Electrical Laboratory and six to problems in Applied Mechanics.

All work must be completed within the assigned laboratory hours.

2511. Properties of Matter, Mechanics and Heat. D. G. Ivey.

Course 5, I Year; 3 hrs. lectures per week, both terms.

Textbook: *Elementary Classical Physics—Vol. 1*—Weidner and Sells.

2512. Physics Laboratory. D. G. Ivey and the staff in Physics.
Course 5, I Year; 3 hrs. laboratory per week, both terms; 1 hr. tutorial per week, both terms.
To accompany subject 2511.

2521. Physics. J. N. P. Hume.
Course 5, II Year; 3 hrs. lectures per week, both terms.
Fundamental theory of electricity and magnetism. Electromagnetic waves. Interference, diffraction and polarization of light waves. Elementary atomic physics.

2522. Physics Laboratory. J. N. P. Hume.
Course 5, II Year; 3 hrs. laboratory per week, both terms.
To accompany subject 2621.

2525. Physics—Heat and Optics. R. Richmond.
Course 1, II Year; 2 hrs. lectures and 1½ hrs. laboratory per week, first term.
Course 8, II Year; 2 hrs. lectures and 3 hrs. laboratory per week, first term.
Thermal expansion, capacity, conductivity; radiation laws. Reflection, refraction, dispersion. Lens systems and optical instruments. Polarising and phase microscopes, interference, diffraction, coherence, optical masers.
Textbooks: *Heat and Sound*—Sears. *Optics*—Sears.

2526. Physics II. A. D. Misener.
Course 7, II Year; 2 hrs. lectures and 3 hrs. Laboratory per week, second term.
Thermal expansion, capacity, conductivity and radiation including Planck's law, Wien's law, Stefan's law, Boltzmann distribution, thermal energy of particle, phonons. Basic concepts of reflection, refraction, dispersion and diffraction.

2531. Statistical Physics. J. C. Stryland.
Courses 5a, 5e, 5g, 5nt, 5p, III Year; 2 hrs. lectures per week, second term.
The fundamental principles of thermodynamics, kinetic theory and statistical mechanics.

2532. Physics Laboratory. J. C. Stryland, H. P. Gush.
Courses 5a, 5e, 5nt, 5p, III Year; 3 hrs. laboratory per week, both terms. Course 5g, III Year; 6 hrs. laboratory per week, first term; 3 hrs. laboratory per week, second term.
To accompany subjects 2531, 2533 and 2534.

2533. Atomic Structure and Quantum Physics. H. P. Gush.
Courses 5a, 5e and 5p, III Year; 2 hrs. lectures per week, both terms.
Waves and particles; Schrodinger equation; harmonic oscillator, hydrogen atom, many-electron atoms; nuclear structure; radioactivity; interaction of radiation with matter.

2534. Physics of Solids and Fluids. R. List.

Courses 5e, 5m, 5p, III Year; 2 hrs. lectures per week, first term.

Elasticity, viscosity, equations of fluid motion, wave propagation, heat conduction, potential theory.

2535. Atomic and Nuclear Physics. K. G. McNeill.

Course 5nt, III Year; 2 hrs. lectures per week, both terms.

Schrodinger equation, hydrogen atom, many electron atoms, radiactivity, nuclear structure, neutron physics, introduction to reactor theory, health physics.

2536. Physics of the Earth. G. D. Garland.

Course 5g, III Year; 2 hrs. lectures per week, both terms.

Seismology and the internal constitution of the earth; the gravitational field; the earth's magnetism and magnetic properties of rocks; radioactivity, geothermal heat and the age of the earth.

2537. Astronomy and Geophysics. P. R. Demarque, A. W. Brewer, J. T. Wilson.

Course 5g, III Year; 2 hrs. lectures per week, both terms.

A survey of astronomy—stars and stellar systems; an introduction to terrestrial and atmospheric Physics.

2541. Electromagnetic Radiation and Matter. H. L. Welsh, R. A. Armstrong.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Propagation of electromagnetic waves, polarization, diffraction, interference, dispersion, scattering. Absorption, spontaneous and stimulated emission, Einstein coefficients. Coherence, maser and laser action.

2542. Physics Laboratory. The Staff in Physics.

Course 5nt, IV Year; 6 hrs. laboratory per week, first term, and 3 hrs. per week, second term.

Course 5p, IV Year; 6 hrs. laboratory per week, both terms.

To accompany the lecture subjects 2541, 2544, and 2545.

2543. Molecular Physics and Statistical Mechanics. E. J. Allin and J. D. Poll.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Quantum theory of rotation and vibration of molecules. Nuclear spins, symmetry, intensity rules, the hydrogen molecule, intermolecular forces. Boltzmann theory, transport equations, the Gibbs method, partition functions.

2544. Nuclear and High Energy Physics. K. G. McNeill, J. D. Prentice.

Courses 5nt, 5p, IV Year; 2 hrs. lectures per week, both terms.

Nuclear forces, alpha-decay, beta-decay. Excited states of nuclei. Nuclear models. Reaction theory. Mesons, anti-particles, hyperons.

2545. Quantum Mechanics. J. Van Kranendonk, L. E. H. Trainor.
Courses 5e, 5p, IV Year; 2 hrs. lectures per week, both terms.
Schrodinger equation, eigenvalues and eigenfunctions. Angular momentum, Pauli spin theory, identical particles. Perturbation theory, transition probabilities. Scattering theory.

2561. Theory and Application of Geophysical Methods. F. S. Grant.
Course 5g, IV Year; 2 hrs. lectures per week, both terms.
A course on the mathematical theory of magnetic, electrical, seismic and gravitational methods in applied geophysics.

2562. Geophysics. F. S. Grant, G. F. West.
Course 5g, IV Year; 7½ hrs. laboratory per week, both terms.
To accompany subject 2561.

2568. Exploration Geophysics. R. M. Farquhar, G. D. Garland.
Course 9, IV Year; 1 hr. lecture per week, both terms.
An introduction to the physical principles underlying the important methods of geophysical prospecting. Particular attention is given to the seismic, gravitational, magnetic and electromagnetic methods.
Textbook: *Introduction to Geophysical Prospecting*—Dobrin.

2569. Geophysics. R. M. Farquhar.
Course 9, IV Year; 3 hrs. laboratory per week, both terms.
To accompany subject 2668.

2571. Atmospheric Physics. A. W. Brewer.
Course 5g, IV Year; 2 hrs. lectures per week, both terms.

2572. Solids within the Earth. J. C. Savage.
Course 5g, IV Year; 1 hr. lecture per week, first term; 3 hrs. per week second term.
The theory and experiments which are pertinent to the mechanical, thermal, and electrical properties of matter at the pressures and temperatures which obtain within the earth.

DEPARTMENT OF CHEMISTRY

2622. Physical Chemistry. S. S. Danyluk.
Courses 6, 8 and 9, II Year; 2 hrs. lectures per week, both terms.
Chemical thermodynamics, phase rule and phase diagrams, electrochemistry, colloids and surface chemistry, kinetics.

2623. Chemistry. M. J. Dignam.
Course 7, II Year; 2 hrs. lectures per week, first term.
Inorganic chemistry, with emphasis on the fundamental particles, atomic structure, the nature of the chemical bond and general structural chemistry.

2624. Analytical Chemistry Laboratory. F. E. Beamish.
Course 8, II Year; 3 hrs. laboratory per week, both terms.
Quantitative analysis.
Eight laboratory reports.

2631. Atomic and Molecular Structure. J. P. Valleau.
Courses 5c, 5m, III Year; 2 hrs. lectures per week, both terms.
To follow course 2621. The application of wave mechanics to some problems of atomic and molecular structure.

DEPARTMENT OF POLITICAL ECONOMY

2720. Economics. A. Kruger, B. D. Bixley, D. M. Nowlan, J. P. Warner.
All courses, II Year; 2 hrs. lectures per week, both terms.
An introduction to the study of Economics with special reference to the problems of the Canadian economy.
Students will be requred to submit at least one essay or book review as part of their term work. Those students who obtain a satisfactory term mark will not be required to write final examination.

2730. Political Science. B. Kovrig.
All courses, III Year (elective); 2 hrs. lectures per week, both terms.
An introduction to the study of government with special reference to the problems of Canadian government.
Students will be required to submit at least one essay or book review as part of their term work. Those students who obtain a satisfactory term mark will not be required to write final examination.

2734. Accounting. W. C. Hebdon.
Course 4, III Year; 2 hrs. lectures per week, both terms.
Basic accounting principles and procedures, the preparation and interpretation of financial statements, cost accounting, and the use of accounting as a means of control.

DEPARTMENT OF PSYCHOLOGY

2840. Industrial Psychology. J. W. Macmillan.
Course 4, IV Year; 2 hrs. lectures per week, second term.
A series of lectures and discussions on some of the human problems in industry, including the selection, classification and training of personnel, performance evaluation and the relationships between motivation and productivity.

DEPARTMENT OF GEOLOGY

2900. Engineering Geology. W. H. Gross.
Course 1, II Year; 2 hrs. lectures per week, first term, 1 hr. second term; 3 hrs. laboratory per week, second term.

An introductory course in geology with special reference to engineering problems.

2901. X-ray Crystallography. E. J. Brooker.
Courses 5m and 8, III Year; 2 hrs. laboratory per week, both terms.
A laboratory course in X-ray diffraction methods for students in Metallurgy and Material Science.

2902. Crystallography. E. W. Nuffield.
Course 5p, III Year; 1 hr. lecture per week, both terms.
Lattices, symmetry operations; classification of crystals into systems, point groups, Laue classes, space groups; crystal classes and forms; the diffraction of X-rays by crystals.

2903. Glacial Geology and Ground Water.
Course 2, IV Year; 1 hr. lecture per week, both terms.
Pleistocene Geology; the formation and distribution of the drift deposits of North America with emphasis on their economic importance.

2920. Principles of Geology. The staff in Geology.
Course 9, II Year; course 5g, IV Year; 2 hrs. lectures, 3 hrs. laboratory per week, both terms.
Basic concepts of physical and historical geology.

2921. Mineralogy. The staff in Geology.
Course 9, II Year; 2 hrs. lectures, 3 hrs. laboratory per week, both terms.
Introductory crystallography; the principles of mineralogy; classification and description of the common minerals; introduction of the study of rocks.

2922. Optical Crystallography. P. A. Peach, D. H. Gorman.
Course 9, II Year; 2 hrs. laboratory per week, both terms.
Optical theory; the use of the polarizing microscope in the study of minerals.

2930. Petrology. P. A. Peach.
Course 9, III Year; 2 hrs. lectures, 2 hrs. laboratory per week, both terms.
The principles of petrology; the classification, description and interpretation of the sedimentary, igneous and metamorphic rocks. Microscopic petrography.
One laboratory report.

2931. Stratigraphy and Sedimentation. F. W. Beales, W. W. Moorhouse.
Course 9, III Year; 2 hrs. lectures, 2 hrs. laboratory per week, both terms.
Principles of stratigraphy with emphasis on tectonic and environmental interpretation of Precambrian and younger rocks. Problems of applied stratigraphy; petrographic interpretation.

2932. Structural Geology. J. B. Currie, W. M. Schwerdtner.
Course 9, III Year; Course 5g, IV Year; 1 hr. lecture, 3 hrs. laboratory per week, both terms.
Development of structures in the sedimentary, igneous and metamorphic rocks of the earth's crust; laboratory study of methods employed in solving structural problems.

2933. Petroleum Geology and Ground Water. J. B. Currie.
Course 9, III Year; 2 hrs. lectures, 3 hrs. laboratory per week, both terms.
Occurrence; theory and application of hydrology to fluid flow in porous media; geological conditions of oil and gas entrapment in sedimentary basins; ground water movement and its relation to drainage basins. Laboratory exercises to accompany the lectures.

2934. Mineral Identification Laboratory. D. H. Gorman.
Course 9, III Year; 2 hrs. laboratory per week, both terms.
A continuation of the laboratory work in mineralogy of course 2921.

2935. Theory of Phase Equilibria. F. G. Smith.
Course 9, III Year; 2 hrs. lectures per week, both terms.
Thermodynamics of phase equilibria, phase diagrams, mineral systems.

2936. Geology Field Camp. The staff in Geology.
Course 2, III Year (7 days); course 9, III Year (14 days).
A field course in the Tweed area of Ontario complementing subjects 2921, 2930 and 2932.

2937. Geological Field Trips. The staff in Geology.
Course 9, III Year.
Field trips to places of geological interest during the fall to complement the subjects studied in the III Year.

2940. Mineral Deposits. W. H. Gross.
Courses 2 and 9, IV Year; 2 hrs. lectures per week, both terms.
Theories of origin of mineral deposits; description of world's important mineral deposits.

2941. Mineral Deposits Laboratory. W. H. Gross.
Courses 2 and 9, IV Year; 3 hrs. laboratory per week, second term.

2942. Geological Data Analysis. F. G. Smith.
Course 9, IV Year; 2 hrs. lectures and 2hrs. laboratory per week, both terms.
Applied mathematics, probability, statistics, computer programming.

2944. Precambrian Geology. W. W. Moorhouse.
Course 2, 5g and 9, IV Year; 2 hrs. lectures per week, first term.

Precambrian formations of Canada—their rocks, distribution, relationships and economic features.

2945. Precambrian Geology Laboratory. W. W. Moorhouse.
Course 2 and 5g, IV Year; 1 hr. laboratory per week, first term.
Course 9, IV Year; 3 hrs. laboratory per week, both terms.
To accompany subject 2944.

2947. Geological Field Trips. The staff in Geology.
Course 9, IV Year.
Field trips to places of geological interest to complement the subjects studied in the IV Year.

2948. Geology of Canada. F. W. Beales.
Course 9, IV Year; 1 hr. lecture per week, both terms.
A reading survey of the physiography, historical geology, major structural features, and mineral deposits of the country.

2949. Pleistocene Geology. R. R. H. Lemon.
Courses 1D and 9, IV Year; 2 hrs. lectures per week, both terms.
Study of the Pleistocene of the world.

SCHOOL OF BUSINESS

3030. Industrial Management. T. C. Graham.
Course 4, III Year; 1 hr. lecture per week, both terms.
A study of the factors involved in the production and distribution of products or services. Consideration will be given to the general concepts of management, organization, leadership and industrial relations but major emphasis will be on work simplification, time and motion study, wage administration and controls of production, quality and costs.

3031. Industrial Management Laboratory. T. C. Graham.
Course 4, III Year; 3 hrs. laboratory per week, both terms.
Cases and problems to accompany the lecture subject.

INSTITUTE OF COMPUTER SCIENCE

3331. Engineering Data Processing. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 2 hrs. lectures per week, second term.
A course in programming and coding for the digital computer.

3332. Engineering Data Processing Laboratory. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 3 hrs. laboratory per week, second term.
Practical work to accompany subject 3331.

3333. Computer Programming I. R. W. P. Anderson.
Course 4, II Year; 1 hr. lecture and 1½ hrs. laboratory per week, both terms.
Coding and programming for the digital computer; machine

organization, machine language and symbolic compiler language (FORTRAN IV); number representation and conversion.

Laboratory exercises are drawn from the fields of engineering and applied science, as well as from those of data processing and elementary compilation.

This subject with suitable modifications will be given to Course 4, III Year in 1966–67 only.

Text: T. E. Hull, *Introduction to Computing*—Prentice-Hall.

3335. Computer Programming II. C. C. Gotleib and R. W. P. Anderson.

Course 4, III Year; 1 hour lecture and 1½ hour laboratory per week, both terms. (Commencing in the session 1967–68)

An extension of the Second Year subject Computer Programming I. More advanced discussion of general and specialized compiler languages and their application in business, engineering and other fields; simulation, data processing, and list processor languages; monte carlo methods; GPSS, SIMSCRIPT, COBOL, etc.

Laboratory problems are selected to complement the lecture material.

SPECIAL LECTURERS

3440. Engineering Law. W. O. Chris. Miller.

Courses 1, 3, 4, 6, and 7, IV Year; 1 hr. lecture per week, first term.

A subject designed to co-ordinate the practice of engineering and law. Consideration is given to the characteristics, advantages and disadvantages of companies, partnerships and sole proprietorships, the promotion, organization and financing of companies, the duties of employees to employers, the duties and liabilities of engineers, statutes applicable to engineering works, professional engineering associations, construction contracts, workmen's compensation, trade unions and industrial disputes.

Textbook: *Engineering Law*—Laidlaw and Young.

SCHOOL OF ARCHITECTURE

3540. Town and Regional Planning. D. Pinker.

Course 1B, IV Year; 1 hr. lecture per week, both terms.

Town Planning principles both past and present. The role of the planner, the plan, local legislation, the central area, the neighbourhood, subdivision, the suburb, open space and the region, housing, road layout, services, industry, commerce and special uses.

3541. Town and Regional Planning. A. Waterhouse.

Course 1B, IV Year; 3 hrs. practical work per week, both terms.

Studio work including exercises in survey, research and analysis, subdivision layout, and urban analysis. These are related to subject 3540.

SECTION IX. GENERAL REGULATIONS; EXAMINATIONS

ATTENDANCE

1. Students proceeding to the degree are required to attend the courses of instruction and the examinations in all subjects prescribed. A student whose attendance at lectures or laboratories, or whose work is deemed by the Council of the Faculty to be unsatisfactory, may have his registration cancelled at any time.

2. Students must conform to all lecture room and laboratory regulations. Reports, briefs, theses and drawings become the property of the Council to dispose of as it may see fit. Drawings, briefs and field notes will not be accepted unless they have been made at the time and place provided in the time table.

TRANSFER OF COURSE

An undergraduate student who wishes to transfer from one course to another within the Faculty must petition to the Faculty Council and obtain its approval. Petitions for transfer of course must be submitted not later than 1 September.

PENALTIES FOR UNSATISFACTORY WORK

(*a*) In the case of unsatisfactory work of a very serious nature, the Faculty Council may recommend to the Senate that a student be debarred from the University.

(*b*) A student who on two occasions has failed to obtain promotion to a higher year will be refused further registration in the Faculty. A failure in engineering or in a related course at another institution will be counted in the same way as a failure in this Faculty.

(*c*) A student whose work is unsatisfactory may be suspended from attendance by the Council of the Faculty for a period of time not exceeding two years and/or until the satisfaction of other conditions as it may see fit.

(*d*) A student who withdraws after February 15, or who does not withdraw but does not write the annual examinations, will be regarded for the purposes of these regulations as having failed his year.

APPEALS

A student wishing to appeal to the Senate against a decision of the Council of the Faculty should consult the Secretary of the Faculty or the office of the University Registrar about the preparation and submission of his petition to the Secretary of the Senate.

ANNUAL EXAMINATIONS

1. Annual examinations will be held in April except as provided in paragraph 2 below.

2. Annual examinations will be held at the beginning of the second term in subjects completed during the first term.

3. Promotion from one year to another is made on the basis of the student's weighted average in the annual examinations and laboratory and other term work. Subjects will be weighted according to the number of hours devoted to them, the hours assigned to laboratory subjects being given one half the weight of those in lecture subjects.

Pass standing and promotion to the next higher year will be granted to students who obtain a weighted average of 60% or greater in the work of the year. (For special requirements in the first year of Engineering Science, see page 41.)

4. The student's work is graded in the following manner:

On Overall Average		*On Individual Subjects*	
Marks	Standing	Marks	Grade
75 — 100%	I Class (Honours)	75 — 100%	I
66 — 74%	II Class	66 — 74%	II
60 — 65%	III Class	60 — 65%	III
Below 60%	Failure	50— 59%	Pass
		Below 50%	Failure or BL

5. A student who obtains the passing average of 60% or greater in the work of the year but who has failed to pass one or more subjects will receive a standing of BL (below the line) in such subjects, and will be promoted to the next higher year.

6. Honour standing will be granted to students who pass in all written and laboratory subjects and who obtain a weighted average of 75% or greater in the work of the year.

7. Honour graduate standing will be granted to students who obtain honours in the final year and in any one previous year.

8. A student who fails in the work of any year will be permitted, unless otherwise ineligible, to register in a subsequent session for the purpose of repeating the year, subject to the following conditions:

(a) Only one such repetition will be allowed in the student's entire undergraduate course. A failure in enginering or in a related course at any other institution will be counted in the same way as a failure in this Faculty.

(b) During any such repetition, the full programme of prescribed instruction must be taken.

(c) Second, Third, or Fourth Year work may be repeated in the session immediately following that in which the failure occurs.

(d) A student who fails in the work for the First Year but who obtained an average of 50% or over will, provided he is otherwise eligible, be allowed to repeat the work of the year in the

following Session. All other students who fail in the work of the First Year must remain out for one Session before re-applying. If a student withdraws on or before 15th February he may re-apply for admission the following Session.

Any student re-applying for admission to the First Year must file a new application (as outlined in Paragraph 5, Section V) with the Registrar of the University.

9. A student should submit to Council immediately after its occurrence, evidence of any illness or mishap which occurs during the session; any petition for leniency on account of such incidents may be refused consideration if received after the third day following the last day of examinations.

10. A student will not be allowed to write any examinations if he has not paid all fees and dues for which he is liable at that time.

TERM EXAMINATIONS

Term examinations may be held in any subject and at any time at the discretion of the instructor, or by the order of the Council, and the results of such examination may be incorporated with those of the annual examinations in the same subjects.

EXTRA-CURRICULAR ACTIVITIES AND ACADEMIC CREDIT

It is in general desirable for students to engage to a reasonable extent in extra-curricular activities in order that they may not become too narrowly professional in interests and outlook, but it will be obvious that no academic credit or consideration can be given for such activities. Some offices in student organizations require quite large amounts of time for the proper performance of the duties connected with them, and it is therefore strongly recommended that students, particularly those whose academic records are not high, consult a senior member of Staff before allowing themselves to be nominated for such offices.

SECTION X. MEDALS, PRIZES, SCHOLARSHIPS, BURSARIES AND FELLOWSHIPS

Through the generosity of friends of the University, governments and commercial organizations, encouragement has been given to both undergraduate and graduate work in the various branches of engineering study by the establishment of the scholarships, prizes, bursaries and medals listed in the following pages.

ADMISSION SCHOLARSHIPS AND BURSARIES

Ontario Students:

Scholarships and bursaries available to students entering the First Year are listed on pages 126 and 127. For full details concerning these awards, applicants should consult the Calendar of Admission Awards, which is available at Secondary Schools or from the Office of Financial Aid, Simcoe Hall, University of Toronto. Applications, which must be made through the Principal of the Secondary School, close on May 1 annually.

Non-Ontario Students:

All non-Ontario students should apply to the Office of Financial Aid, Simcoe Hall, University of Toronto. A limited number of scholarships is reserved for students living outside the Province of Ontario, but as competition is keen such students must not count on receiving assistance but are advised rather to ensure that they have sufficient funds from their own government or from private sources to cover all probable expenses.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed on pages 127 to 132. Where it is necessary to make application for an award it is so stated in the description and particulars are given as to how the application should be made. In all other cases the award is made on the recommendation of the Faculty Council and no application is necessary.

GENERAL TERMS AND CONDITIONS

In order to be eligible for a medal, prize, scholarship, bursary, fellowship or other award granted solely upon standing obtained at an annual or special examination or upon an essay, or term work, or other academic rating, a candidate must obtain honours at such annual or special examination or upon such essay, term work, or other academic rating unless the terms of the award or medal specify that standing lower than honours may be accepted.

When an award or medal is granted upon standing obtained on part of the work of any academic year the candidate must obtain standing but need not obtain honours in the work of the academic year as a whole, provided he obtains honours in the part concerned, unless the terms of the award or medal specify otherwise.

No medal, prize, scholarship, bursary, fellowship or other award will be granted to a candidate who is conditioned in any subject at an annual examination or in Physical Education unless the terms of the award or medal specify otherwise.

A candidate will not be permitted to receive more than one award in a session unless the statute establishing each of the awards concerned or the Calendar specifies otherwise. Only one of those marked by an asterisk may be held in any one year. A candidate who would, but for this provision, have received more than one award may have his name so published in the class lists.

A candidate who has spent two sessions in any year of an undergraduate course is not eligible to compete for any award at the annual examinations of that year.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes other than awards for graduate study and research, will be paid in one instalment as soon as possible after the granting of the awards.

All other awards will be paid (i) if of the value of $100 or less, in one instalment on November 20 and (ii) if of the value of more than $100 in two equal instalments, the first on November 20 and the second on January 20, in the session following the granting of the awards. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

The Senate may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance upon lectures and laboratory classes for one year. Further postponement may be permitted on application.

Name	Value	Application required	Available only to a limited group or single course	See page
AVAILABLE TO STUDENTS ENTERING THE FIRST YEAR				
Alumni Association War Memorial Scholarships	$500	Yes	No	159
Alcan Scholarship	$500	Yes	No	133
J. P. Bickell Foundation Scholarships	$500	Yes	No	136
J. W. Billes Admission Scholarships	—	Yes	No	137
Dominion Magnesium Limited Bursary	$400	Yes	Yes	139

Name	Value	Application required	Available only to a limited group or single course	See page
Engineering Alumni Admission Bursaries	—	Yes	No	140
Engineering Alumni Admission Scholarships (7)	$1000	Yes	No	140
Grabill Admission Scholarship	$500	Yes	No	142
General Foods Scholarships	$500	Yes	No	142
Hagarty Memorial Scholarship	$60	Yes	Yes	143
The Murray Calder Hendry Scholarship	$500	Yes	No	144
International Nickel Scholarship	$300 + Fees	Yes	No	145
The Leonard Foundation Scholarships	—	Yes	Yes	146
J. Edgar McAllister Foundation	—	Yes	Yes	147
O.H.A. War Memorial Scholarship	$200	Yes	Yes	151
Ontario Chapter American Society for Metals Bursaries (2)	$400	Yes	Yes	134
Ontario Student Awards Programme	—	Yes	No	139
A.P.E.O. Admission Scholarship	$500	Yes	No	152
Regular Officer Training Plan	—	Yes	No	154
Helen E. Rogers Admission Scholarships	—	Yes	Yes	155
Simpson-Sears Limited (Northern Ontario) Scholarship	$100	Yes	Yes	156
Smith and Stone Limited Bursaries	$150	Yes	Yes	156
Walter Sterling Admission Scholarships	—	Yes	No	157
U.T.S. Engineering Scholarship	$250	Yes	Yes	160
Wallberg Admission Scholarships (2)	$500	Yes	No	160
AVAILABLE TO STUDENTS COMPLETING THE FIRST YEAR				
Atkinson Incourse Bursaries	—	Yes	No.	135
Baptie Scholarship	—	No	Yes	135
Canadian Bechtel Limited Bursaries	—	Yes	No	136
J. P. Bickell Foundation Scholarships	—	No	No	137
T. H. Bickle Prize	$30	No	Yes	137

Name	Value	Application required	Available only to a limited group or single course	See page
Crocker Foundation Bursaries	—	Yes	No	138
*John M. Empey Scholarship	$150	No	No	140
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	145
Inco Scholarship	—	Yes	Yes	145
Johnson's Wax Scholarship	$800	No	Yes	145
Kimberly-Clark Scholarship	$500	No	No	146
John Wolfe McColl Awards	—	Yes	No.	147
Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science	$95	No	Yes	148
MacLennan-LacLeod Memorial Prize	$25	No	No	149
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	150
Northern Electric Undergraduate Scholarship	$500	No	Yes	151
Ontario Student Awards Programme	—	Yes	No	139
Orenda Engines Scholarship	$500	No	Yes	144
Paulin Memorial Scholarship	$425	No	No	152
Procter and Gamble Bursary	—	Yes	No	152
*Professional Engineers Scholarship	$250	No	Yes	152
*Ransom Scholarship in Chemical Engineering	$150	No	Yes	153
Frederick W. Schumacher Scholarship	—	Yes	Yes	155
S. Ubukata Fund	—	Yes	Yes	159
University Naval Training Division Bursaries	$100	Yes	Yes	160
University of Toronto General Bursaries	—	Yes	No	160
*Wallberg Undergraduate Scholarships (2)	$500	No	No	161
AVAILABLE TO STUDENTS COMPLETING THE SECOND YEAR				
*Harvey Aggett Memorial Scholarship	$75	No	No	133
Ardagh Scholarship	$350	No	Yes	134
Automotive Transport Association Bursary	—	Yes	No	135
Babb Bursary Fund	—	Yes	Yes	135

Name	Value	Application required	Available only to a limited group or single course	See page
Canadian Bechtel Limited Bursaries	$1200	Yes	No	136
J. P. Bickell Foundation Bursaries	—	Yes	Yes	137
J. P. Bickell Foundation Scholarships	—	No	Yes	136
T. H. Bickle Prize	$30	No	Yes	137
Carveth Metallurgical Ltd. Bursary	$500	Yes	Yes	138
Crocker Foundation Bursaries	—	Yes	No	138
Cyanamid of Canada Scholarship	$900	No	Yes	139
*John M. Empey Scholarship	$150	No	No	140
J. A. Findlay Scholarship	—	No	Yes	141
Hugh Gall Award	$140	Yes	No	142
Hydro-Electric Power Commission of Ontario Bursary	$500	Yes	No	144
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	145
The Kennecott Copper Award in Industrial Engineering	$1000	Yes	Yes	146
Kimberly-Clark Scholarship	$500	No	No	146
The Lever Brothers Scholarships	$300	No	Yes	147
Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships	—	No	Yes	148
Charles Gordon Manning Prize	—	No	No	149
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	150
James L. Morris Memorial Prize	$125	No	Yes	150
Northern Electric Undergraduate Scholarship	$500	No	Yes	151
Ontario Student Awards Programme	—	Yes	No	139
Orenda Engines Scholarship	$500	No	Yes	144
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	157
William Storrie Memorial Scholarship	$100	No	Yes	158
*Professional Engineers Scholarship	$250	No	Yes	152
*Rhodes Scholarship	£400	Yes	No	153

Name	Value	Application required	Available only to a limited group or single course	See page
Scottish Rite Masons Bursary	$400	Yes	Yes	155
Frederick W. Schumacher Scholarship	—	Yes	Yes	155
Edith Tyrrell Memorial Bursary	$600	Yes	Yes	158
University of Toronto Chemical Engineering Club Scholarship	$150	No	Yes	159
University of Toronto General Bursaries	—	Yes	No	160
*Wallberg Undergraduate Scholarships	$500	No	No	161
*William R. Worthington Memorial Scholarship	$400	No	Yes	161
AVAILABLE TO STUDENTS COMPLETING THE THIRD YEAR				
Allied Chemical Canada Limited Scholarship	$950	No	Yes	134
American Institute of Industrial Engineers Scholarship	$150	No	Yes	134
Babb Bursary Fund	—	Yes	Yes	135
F. W. Baldwin Prize	$75	No	Yes	135
Canadian Bechtel Limited Bursaries	—	Yes	No	136
J. P. Bickell Foundation Bursaries	—	Yes	Yes	137
T. H. Bickle Prize	$30	No	Yes	137
*Boiler Inspection and Insurance Company Scholarship	$150	No	Yes	137
*Chevron Standard Limited Scholarship	$400	No	Yes	138
Chemical Institute of Canada Prize	$25	No	Yes	138
Crocker Foundation Bursaries	—	Yes	No	138
Dow Chemical of Canada Limited Award	$500	No	Yes	139
*John M. Empey Scholarship	$150	No	No	140
E.I.C. Prize	$50	No	Yes	141
Engineering Society Semi-Centennial Award	$75	No	No	141
J. A. Findlay Scholarship	—	No	Yes	141
James Franceschini Foundation Scholarship	$250	No	Yes	141

Name	Value	Application required	Available only to a limited group or single course	See page
Chester B. Hamilton Scholarship	$500	No	Yes	143
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	145
*Jenkins Scholarship in Engineering	$200	No	No	145
Kennecott Copper Award in Industrial Engineering	$1000	Yes	Yes	146
The Lever Brothers Scholarship	$300	No	Yes	147
Loan Funds	—	Yes	No	161
J. A. D. McCurdy Prize	$75	No	Yes	147
Alexander MacLean Scholarship	$250	No	Yes	149
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	150
Northern Electric Undergraduate Scholarship	$500	No	Yes	151
Ontario Student Awards Programme	—	Yes	No	139
Orenda Engines Scholarship	$500	No	Yes	144
*Professional Engineers Scholarship	$250	No	Yes	152
RCE Memorial Scholarship	$125	Yes	Yes	154
Murray F. Southcote Scholarship	$100	No	No	157
Frederick W. Schumacher Scholarship	—	Yes	Yes	155
Specification Writers Association Scholarship	$250	No	Yes	157
William Storrie Memorial Scholarship	$100	No	Yes	158
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	157
Edith Tyrrell Memorial Bursary	$600	Yes	Yes	158
University of Toronto General Bursaries	—	Yes	No	160
*Wallberg Undergraduate Scholarships	$500	No	No	161
AVAILABLE TO STUDENTS COMPLETING THE FOURTH YEAR				
Henry G. Acres Medal	—	No	Yes	133
American Society of Lubrication Engineers Prize	$75	No	Yes	134

Name	Value	Application required	Available only to a limited group or single course	See page
J. P. Bickell Foundation Bursaries	—	Yes	Yes	137
Babb Bursary Fund	—	Yes	Yes	135
Crocker Foundation Bursaries	—	Yes	No	138
Electrical Manufacturing Co. Limited Prize	$25	No	Yes	140
Hamilton Watch Award	—	No	No	143
Ontario Chapter, A.S.H.R.A.E. Prize	$75	No	No	143
Loan Funds	—	Yes	No	161
Massey-Ferguson Ltd. Scholarships (2)	$500	Yes	Yes	150
Ontario Municipal Electric Association Bursary	$300	Yes	Yes	151
Ontario Student Awards Programme	—	Yes	No	139
Professional Engineers Gold Medal	—	No	No	153
William Storrie Memorial Scholarship	$200	No	Yes	158
Society of Automotive Engineers Prize	$100	No	No	157
Society of Chemical Industry Merit Award	—	No	Yes	157
"Second Mile Engineer" Award	$200	No	Yes	155
Trane Company of Canada Limited Prize	$200	No	No	158
University of Toronto General Bursaries	—	Yes	No	160
W. S. Wilson Medals	—	No	No	161

NOTE—As the value of an endowed scholarship or prize is dependent on the actual income of the fund, it is possible that the value of certain scholarships and prizes at the time of payment may be less than the amount stated in the calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

HENRY G. ACRES MEDAL

The Henry G. Acres Medal is the gift of Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario in the period 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. Entering private practice in 1924, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which was vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

This medal is awarded annually to the student in the Fourth Year who is registered in the course in Civil, Mechanical, or Electrical Engineering, and who obtains the highest aggregate percentage at the annual examinations of the Third and Fourth Years, provided always that the student obtains honour standing in the examinations of the Fourth Year. Receipt of the medal does not preclude a student from being granted such other award as may in the opinion of the Council be appropriate.

HARVEY AGGETT MEMORIAL SCHOLARSHIP

This scholarship was donated by the late Mr. J. T. Aggett, of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual scholarship of the value of the annual income from the fund is to be awarded to a student of the Second Year in this Faculty who, obtaining honours and being one of the first three in his year by his standing at the annual examinations, has been adjudged highest of the three in general student activities and service in the University during his period of attendance. When regulations do not permit the winner to hold this scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a scholarship of higher value.

ALCAN SCHOLARSHIP

The Aluminum Company of Canada, Limited has made available an admission scholarship of a value of $500 to a student entering the First Year of an Honours Course in the Faculty of Arts and Science, the

Faculty of Applied Science and Engineering or in the Faculty of Law. The recipient must attain an academic standing satisfactory to the Committee of Award and demonstrate financial need. It is tenable in the later years provided First Class standing is maintained.

Application should be made to the Registrar of the University by May 1 on the regular Admission Scholarship Application form.

ALLIED CHEMICAL CANADA LIMITED SCHOLARSHIP

Allied Chemical Canada Limited has presented a scholarship of the value of tuition fees plus $250 to the student and a grant of $250 to the University, to be awarded to a student registered in the Fourth Year of the course in Chemical Engineering who has attained honour standing in the examinations of the Third Year. The recipient must be a Canadian or an American citizen and must not already be receiving other awards exceeding $250.

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS SCHOLARSHIP

The Southern Ontario Chapter, American Institute of Industrial Engineers offers a scholarship of $150 to a student entering the Fourth Year of the Industrial Engineering course who has consistently maintained a high academic standing, but not necessarily honour standing, during the previous three years.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS PRIZE

The Toronto Section of the American Society of Lubrication Engineers offers an annual prize of $75 to a student in the Fourth Year in Mechanical Engineering whose Thesis dealing with Lubrication is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory. The Prize is accompanied by a donation of $25 to the Department to purchase books on Lubrication.

ONTARIO CHAPTER, AMERICAN SOCIETY FOR METALS BURSARY

The Ontario Chapter, American Society for Metals provides two bursaries of a value of $400 each for students entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made for the Session 1958–59.

ARDAGH SCHOLARSHIP

The Ardagh Scholarship, of the annual value of the income from $7,500, has been provided in memory of his parents by Professor E. G. R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry in the

Faculty. It is awarded to the student who attain the highest standing in Honours at the annual examinations of the Second Year in the Course in Chemistry Engineering. The first award was made on the results of the annual examination of 1946.

ATKINSON IN-COURSE BURSARIES

Atkinson In-Course Bursaries, gift of the Atkinson Charitable Foundation, are awarded annually to students in the second or higher years of their courses. Applicants must have at least Second Class honours in the final examinations of the preceding year, demonstrate financial need and be a resident of the Province of Ontario.

Applications must be submitted to the Registrar of the University on or before December 1.

ATA TRUCKING INDUSTRY EDUCATIONAL FOUNDATION BURSARIES

The Automotive Transport Association of Ontario has established a bursary fund for students in the second or higher years of any undergraduate degree course who find themselves in serious financial need due to sudden, unexpected personal or family difficulties. Applications may be submitted to the University Registrar at any time during the session and the number and value of the bursaries will vary at the discretion of the Committee of Award.

THE BABB BURSARY FUND

Bursaries from this fund are available to students in any year of the Aeronautics Option in Engineering Science. Application is made through the Secretary of the Faculty.

THE F. W. BALDWIN PRIZE

The F. W. Baldwin Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44), in memory of Frederick Walker "Casey" Baldwin, a graduate of the School of Practical Science, who made a significant contribution in the field of Aeronautics in Canada; and who flew, on March 12, 1908, near Hammondsport, N.Y., the "Redwing," the first biplane built by the Aerial Experiment Association.

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in the annual examinations of Third Year in "structural subjects."

The first award was made on the results of the examinations of the Session 1953–54.

BAPTIE SCHOLARSHIP

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie, of Ottawa, and the Board of Governors has directed that a scholarship of one half the annual income shall be awarded annually to an engineering student on the record of

the first Year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to $75.

The conditions of the award are as follows: That the scholarship be awarded to the student who, in the annual examinations of the First Year, enrolled in any one of the courses of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, or Metallurgy and Materials Science, obtains the highest aggregate percentage of marks in those subjects which are common to the First Year curricula of those courses. The first award was made on the results of the annual examinations of the Session 1925–26.

CANADIAN BECHTEL LIMITED BURSARIES

Canadian Bechtel Limited has established Bursaries in the Faculty of Applied Science and Engineering of an annual value of $1,200 to provide not more than four awards, each of a minimum value of $200 and a maximum value of $600. Two awards will be made to First Year students and one or two awards to students registered in any year of the Faculty. Applicants must demonstrate financial need and have academic standing satisfactory to the Faculty Council.

Application must be made to the Secretary of the Faculty on or before October 1.

J. P. BICKELL FOUNDATION SCHOLARSHIP

The Trustees of the J. P. Bickell Foundation have established scholarships, the number to be determined annually, in the Faculty of Applied Science and Engineering of a possible value of $1,500 payable $500 in the First Year and provided honours are obtained at the Annual Examinations, $500 in the Second and Third Years.

An applicant must obtain an average of at least 75% at the Ontario Grade XIII examinations immediately preceding his admission to the university and must undertake to enrol in Chemical Engineering, Metallurgy and Materials Science or Geological Engineering. Failing suitable candidates in the courses mentioned students registered in the Second Year Honour course in Geological Sciences, or Physics and Geology in the Faculty of Arts and Science who are academically qualified are eligible. These awards are of the same value and are tenable in the Second, Third and Fourth Years of the course, subject to maintenance of the required academic standing. If any scholarships are not awarded to those mentioned above, students registered in the Third Year of the Engineering Science course in the Faculty of Applied Science and Engineering and taking the Physical Metallurgy or the Geophysics option who are academically qualified are eligible. In this case the scholarship will have a value of $1,000, payable $500 in each of the Third and Fourth years, provided the required academic standing is maintained.

Applications from those entering First Year must be submitted to the Registrar of the University not later than May 1 on the regular admission scholarship application form. In other cases, applications are not required.

J. P. BICKELL FOUNDATION BURSARIES

The Trustees of the J. P. Bickell Foundation have established the J. P. Bickell Foundation Bursaries in the Faculty of Arts and the Faculty of Applied Science and Engineering. An applicant must be enrolled in Honour Science or in Mathematics, Physics and Chemistry in the Faculty of Arts, in which case he must undertake to study mining or geology in his higher years; or be enrolled in a higher year of an honour course in the geological or geophysical field in the Faculty of Arts; or be enrolled in Chemical Engineering, Mining Engineering, Metallurgy and Materials Science, or Geological Engineering in any year of the Faculty of Applied Science and Engineering. He must demonstrate financial need and have satisfactory academic standing.

Application must be made to the Registrar of the University on or before December 1.

THE T. H. BICKLE PRIZE

The T. H. Bickle Prize is the gift of Mr. and Mrs. E. W. Bickle in memory of their son, T. H. Bickle, an undergraduate of Trinity College and a member of the Senior Intercollegiate Swimming Team at the time of his death in 1937. The income from the endowment fund will be used to purchase a suitable prize to be awarded annually to a member of the Senior Intercollegiate Swimming Team of this University in any year, faculty or school. The Committee of Award shall consist of the Dean of the Faculty of Arts, the University Registrar, the Director of Athletics, and the Honorary Coach of Swimming. In awarding the Prize the Committee shall consider the character, scholarship, and general interests of the members of the team.

J. W. BILLES ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of J. W. Billes, open to students entering any degree course in the University. The value in each year is a minimum of $200 and a maximum of $1,500 dependent upon the financial need of the recipient. Applicants must satisfy the normal admission scholarship standards in their Grade XIII examinations to be eligible for an award and maintain first class honour standing to enjoy the scholarship in higher years. The number of scholarships awarded in any one year may be varied dependent upon the available funds.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

BOILER INSPECTION AND INSURANCE COMPANY SCHOLARSHIP

The Boiler Inspection and Insurance Company of Canada offers a scholarship in the Course in Mechanical Engineering of the value of $150 to the student who obtains highest honour standing in the regular examinations of the Third Year.

The successful candidate will be expected to proceed to his Fourth Year during the session next following the date of the award.

The amount of the award will be credited by the Chief Accountant to the fees of the Fourth Year of the successful candidate.

CHEVRON STANDARD LIMITED SCHOLARSHIP

Chevron Standard Limited has presented a scholarship of $400 to a student who achieves outstanding results in the annual examinations of the Third Year in the Geophysics Option in Engineering Science or in Geological Engineering in the Faculty of Applied Science and Engineering or achieves the highest standing at the annual examinations of the Third Year in Physics and Geology or Geological Sciences in the Faculty of Arts and Science.

The awards alternate annually between the Faculties of Applied Science and Engineering and Arts and Science and the First Award was made in the session 1960–61 in the Faculty of Applied Science and Engineering.

CARVETH METALLURGICAL LTD. BURSARY

Carveth Metallurgical Ltd. provides one or more bursaries to a total value of $500 for students entering the Third Year of Metallurgy and Materials Science. The award is made primarily on the basis of Second Year standing, but the need for financial assistance will also be taken into consideration.

The Bursary is available every third year, beginning in the Session 1961–62, and is to be awarded on the recommendation of the Department of Metallurgy and Materials Science. Applications should be made by letter to the Secretary of the Faculty of Applied Science not later than September 1 of the year in which the award is tenable.

CHEMICAL INSTITUTE OF CANADA PRIZE

The Chemical Institute of Canada offers a prize of the annual value of $25 in books to the student registered in the course in Chemical Engineering who, having obtained honours, receives the highest standing in the written and laboratory work of the Third Year.

The first award was made on the results of the final examinations of 1947.

CROCKER FOUNDATION BURSARIES

The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

CYANAMID OF CANADA SCHOLARSHIP

As a part of their programme to encourage technical development in Canada, Cyanamid of Canada Limited offers a scholarship of the value of $900 to a student entering the Third Year in Chemical Engineering or Industrial Engineering. The award is made to a student who has demonstrated high academic ability and outstanding scholarship in the work of the Second Year.

The first award at the University of Toronto was made in 1964.

DOMINION MAGNESIUM LIMITED BURSARY

Dominion Magnesium Limited provides a bursary of $400 for a student entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made in the Session 1958–59.

PROVINCE OF ONTARIO STUDENT AWARDS PROGRAMME

Awards under this programme will be made available to all Ontario students provided:

(i) they are in full-time attendance at a Canadian University (or other eligible institution).
(ii) they can demonstrate need of financial assistance.
(iii) they are either Canadian citizens or landed immigrants, have resided in Canada for at least twelve months and intend to reside permanently in Canada.

Each applicant's need will be assessed by the Department of University Affairs and the first $150 of the total established need will be paid in loan form. Of the balance 60% will be made available as a loan and 40% will be in the form of a bursary.

Application forms and further information are available at high schools for students entering the first year; students in attendance in the Faculty may obtain application forms from the Secretary.

DOW CHEMICAL OF CANADA LIMITED AWARD

Dow Chemical of Canada Limited have provided funds for an annual award of $500 to a student in Chemical Engineering in the Faculty of Applied Science and Engineering, and a grant-in-aid of $250 to be used in the winner's department to help defray the cost of equipment, supplies and administration.

The winner must:

(*a*) be registered in the Third Year in Chemical Engineering (the award will be made in the second term of the Third Year and will be paid to the winner during his Fourth Year);
(*b*) be in the upper half of the class;
(*c*) have demonstrated leadership in extra-curricular activities.

The award is not tenable with other awards in the gift of the Senate. Application is not required.

THE ELECTRICAL MANUFACTURING COMPANY LIMITED PRIZE

The Electrical Manufacturing Company Limited has established an annual Prize of $25 in the Faculty of Applied Science and Engineering.

The winner must:

(*a*) be registered in the Fourth Year in Electrical Engineering;

(*b*) obtain the highest aggregate percentage of marks at the final examinations in the subjects of the Fourth Year related to electrical distribution equipment, the subject to be determined by the Head of the Department of Electrical Engineering.

This Prize is tenable with other awards in the gift of the Senate.

THE JOHN M. EMPEY SCHOLARSHIPS

The John M. Empey Scholarship Fund was established under a bequest of $10,000 in the Will of the late John Morgan Empey, B.A.Sc., 1903. Three scholarships of equal value are provided from the income from the Fund. One of these scholarships is awarded in each of the First, Second, and Third Years on the results of the annual examinations, to a student who, taking honours, obtains the highest average percentage of marks in the written and laboratory subjects of his Year. The scholarships are open to any students registered in the Faculty. In case the winner of any one of these scholarships does not attend this Faculty during the session next following the award, the right to the scholarship shall be forfeited and the award shall be made to another eligible student. The scholarships were awarded for the first time in 1944.

ENGINEERING ALUMNI ADMISSION BURSARIES

The Engineering Alumni Association has made a number of bursaries with a maximum value of $600 each available annually. Applicants must be residents of Ontario, register in the First Year of the Faculty of Applied Science and Engineering, and need financial assistance.

Applicants should consult their secondary school Principal for details. Further information may be obtained from the Chairman, Engineering Alumni Education Committee, Faculty of Applied Science and Engineering, University of Toronto.

ENGINEERING ALUMNI ADMISSION SCHOLARSHIPS

Seven scholarships, each of the value of $1000, are provided annually by the University of Toronto Engineering Alumni Association for students entering the first year of any course in the Faculty of Applied Science and Engineering. The awards are made on the basis of standing in the Ontario Grade XIII examinations.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

ENGINEERING INSTITUTE OF CANADA PRIZE

The Engineering Institute of Canada, having in view that one of its objects is to facilitate the acquirement and interchange of professional knowledge among its members, offers an annual prize of Fifty Dollars in this University, commencing 1931, to the student who, in his Third Year in any one of the six courses of Engineering, has proved himself most deserving as disclosed by the examination results of the year, in combination with his activities in the Engineering Society or with a local branch of another recognized engineering organization.

ENGINEERING SOCIETY SEMI-CENTENNIAL AWARD

The Engineering Society Semi-Centennial Award, to the value of $75 was established in 1931 to commemorate the semi-centennial of the founding of the "School". The award is made to a student entering the final year.

The selection is based upon the following qualifications, which bear equal weight in the selection of the winner: (*a*) General "School" activities. (*b*) Contributions to the Engineering Society Executive Committee. (*c*) Personality, and social and athletic activities. (*d*) Academic standing.

J. A. FINDLAY SCHOLARSHIPS

These scholarships were established through a legacy bequeathed by the late Miss Janet Findlay to the Department of Mechanical Engineering. Two scholarships are available, each of a value of one half of the income of the fund, to students in this Course, one for a student in the Third Year, the other for a student in the Fourth Year, but only if the student continues his course in Mechanical Engineering. The selection will be made, on recommendation of the Head of the Department of Mechanical Engineering, from amongst the four students having the highest average percentage of marks at the annual examinations in the Second and Third Years respectively, but in making the award the student's general character, fitness for his profession, and financial circumstances will be given consideration. In case a student who has been awarded one of the scholarships changes his course or does not attend this University during the next following session, he shall forfeit his right to the scholarship and the award shall be made to another eligible student.

THE JAMES FRANCESCHINI FOUNDATION SCHOLARSHIP

This scholarship, of a value of $250, is awarded to the student in Civil Engineering who achieves the highest standing, with honours, at the annual examinations of the Third Year among those who do not hold an award of a value of $100 or more based on the results of these examinations.

HUGH GALL AWARD

The Hugh Gall Award, of the annual value of One Hundred and Forty Dollars, the gift of the Graduate Class of 1910, "to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career", was established in 1946 for a five year period and, through the generosity of Mrs. Hugh Gall extended for a further three year period. It is awarded to a student, who, having completed his First Year with a general average of at least 66% without conditions, has entered the Second Year, and is in special need of financial assistance in order to enable him to continue his course. It is desirable, but not necessary, that the recipient shall not already have been given any other scholastic award or scholarship applicable to the second year and he shall have shown indications of his firm intention and ability to follow successfully the profession of engineering.

Any second year student in the Faculty of Applied Science and Engineering is eligible to apply for this Bursary. Applications should be made to the Secretary of the Faculty not later than one month after the opening of the session.

GENERAL FOODS SCHOLARSHIP

This scholarship is awarded for general proficiency in the final secondary school year to a student entering the Faculty of Arts and Science, Applied Science and Engineering or Food Science, and is open for competition by any student resident in Canada. The value is $500 for each of four years, providing first class standing in maintained.

Ontario residents apply on the regular admission scholarship application form.

Students resident outside Ontario may obtain application forms from the Awards Department, Office of the Registrar, University of Toronto.

THE GRABILL ADMISSION SCHOLARSHIP

The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $500. It is awarded to the candidate who has standing amongst those with the highest average percentages in the subjects of Ontario Grade XIII required for admission to the Faculty of Applied Science and Engineering. Applicants are required to write the Problems paper but standing in this paper is used only as auxiliary information. The candidate must write the Grade XIII examinations at one sitting in the June preceding entry to the University after not more than one year's instruction in Grade XIII and must register in the Faculty of Applied Science and Engineering.

Application should be made to the Registrar of the University on the regular Admission Scholarship form by May 1.

THE REGINALD AND GALER HAGARTY SCHOLARSHIP

The Reginald and Galer Hagarty Scholarship, in memory of the dearly beloved sons of Lieutenant-Colonel E. W. Hagarty, B.A. 1883, M.A. 1908, and Charlotte Ellen Hagarty, his wife. Reginald Edward Walter Hagarty, B.A.Sc. (Honours) 1908, a graduate of the University in the Faculty of Applied Science and Engineering and at the time of his death on April 29, 1925, a Consulting Structural Engineer. Lieutenant Daniel Galer Hagarty, Princess Patricia's Canadian Light Infantry, a member of the class of 1916 in Applied Science, enlisted for the Great War at the end of his third year in June, 1915, killed in action in Sanctuary Wood, June 2, 1916. The scholarship is given in recognition of the fact that their father was an honour graduate in Classics of the University of Toronto. It is of the value of the annual interest on the capital sum of $2,000 and is to be awarded to a student who has been enrolled for his Grade XIII Year at Harbord Collegiate Institute and having obtained at least the required standing in each of the Grade XIII subjects necessary for admission to the Faculty, obtains the highest standing in English, a language other than English, and Mathematics, among the students who apply for the award from the Collegiate. He will be required to: (*a*) register in the Faculty of Applied Science and Engineering, (*b*) sign a declaration to the effect that he is willing to take up arms in the defence of Canada and the British Commonwealth should necessity arise as declared by the Parliament of Canada. The Scholarship was offered for award for the first time in 1945. Application should be made to the Registrar of the University on the regular admission scholarship application form not later than May 1.

CHESTER B. HAMILTON SCHOLARSHIP

Members of the family of the late Chester B. Hamilton, a graduate of this Faculty in 1906, have presented a Scholarship in his memory of the annual value of $500. It is held by a Fourth Year student in Mechanical Engineering who has achieved outstanding academic standing at the Annual Examinations of the Third Year.

The first award was made on the results of the examinations for the Session 1958–59.

HAMILTON WATCH AWARD

Hamilton Watch Company, Lancaster, Pa. presents a wrist watch, suitably engraved, to the Fourth Year student in the Faculty of Applied Science and Engineering who at the annual examinations attains Honour standing and who has achieved high aggregate marks during his four years in the social-humanistic subjects common to all courses.

ONTARIO CHAPTER, A.S.H.R.A.E. PRIZE

The Ontario Chapter of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers offers an annual prize of $75, first awarded in 1931, for a period of five years, and extended

indefinitely in 1935. The prize will be awarded to a student in either the Third or Fourth Year in any Course of the Faculty who, in the opinion of the Department of Mechanical Engineering, has written the most satisfactory thesis on a subject dealing with heating, ventilating, air-conditioning or refrigeration, such thesis being prepared under special arrangements made by the Department of Mechanical Engineering, the result to be reported to the Council with the annual examination results. The thesis must be handed in not later than February 15. The prize will not necessarily be awarded in any year.

Application should be made to the Department of Mechanical Engineering.

HAWKER SIDDELEY CANADA LIMITED (ORENDA ENGINES DIVISION) SCHOLARSHIPS

Hawker Siddeley Canada Limited (Orenda Engines Division) have donated three scholarships each of a value of $500, awarded annually to students completing the First, Second and Third Years respectively in courses other than Geological Engineering. These scholarships are awarded to students with high academic standing and in cases of close competition, preference will be given to the student who indicates that he possesses initiative and leadership qualities and that he will be a credit to his profession after graduation.

This award may be held with other awards provided that the monetary value of the other awards does not exceed $100. The first award was made in the Session 1955–56.

THE MURRAY CALDER HENDRY SCHOLARSHIP

This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of the income from a capital sum of $10,000 and the recipient must:

(*a*) have attained an average of at least 75% on nine grade XIII examination papers, written at one sitting, required for admission to the Faculty and have the highest marks in the Problems paper;

(*b*) be entering the First Year of any course in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University by May 1 on the regular University Admission Scholarship Application form.

The first award was made in the Session 1962–63.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO BURSARY

The Hydro-Electric Power Commission of Ontario has provided a bursary of the value of $500, which may be awarded to a student entering the second year of the courses in Mathematics and Physics or Commerce and Finance in the Faculty of Arts and Science, or any course in the Faculty of Applied Science and Engineering. Application should be made on the regular in-course bursary form not later than December 1.

IBM—THOMAS J. WATSON MEMORIAL BURSARY FUND

International Business Machines Company Limited has made available one or more bursaries of a total annual value of $1,000 to students registered in any year of a full time course in the university who have standing satisfactory to the Committee of Award and demonstrate financial need.

Application should be made to the Registrar of the University by October 31.

INTERNATIONAL NICKEL SCHOLARSHIPS

The International Nickel Company of Canada, Limited, annually provides one scholarship to students entering the University of Toronto for studies in Engineering, Geology, Geophysics, Mathematics, Physics or Chemistry with preference being given to Metallurgical Engineering. Awards are renewable for three additional academic years provided satisfactory standing is maintained.

Valued at $1,200 annually, each scholarship provides for tuition and fees, a $300 living allowance, and a grant of up to $500 to the University as a cost-of-education supplement.

To be eligible for consideration the applicant must obtain an average of 75% or over in the Ontario Grade XIII subjects required for admission to his course and demonstrate financial need.

Application must be made to the Registrar of the University by May 1 on the regular scholarship application form.

JENKINS SCHOLARSHIP

The Jenkins Scholarship, presented by Jenkins Bros., Limited, Montreal, first awarded in 1925, has been donated to continue indefinitely.

This Annual Scholarship, of the value of $200, is awarded to the student of the Third Year registered in any course of the Faculty who has the highest aggregate of percentages for the First, Second, and Third Years.

JOHNSON'S WAX SCHOLARSHIP

S. C. Johnson and Son Limited, Brantford, Ontario, have established a Scholarship of an annual value of $800 in each of the Second, Third and Fourth Years or a total possible value of $2,400.

The recipient must:

(*a*) be registered in Chemical Engineering in the years in which the Scholarship is awarded and held;

(*b*) in the opinion of the Council be the most promising and deserving member of the class, obtaining Honours in the final examinations of the First Year;

(*c*) in his Second and Third Years, maintain academic standing satisfactory to the Council, not necessarily Honours, for the continued enjoyment of the Scholarship.

In its discretion the Council may recommend the award of any portion of the Scholarship, lost by the original recipient by failure to maintain

satisfactory academic standing, to another student of the year(s) in which the Scholarship would otherwise have been enjoyed.

The first award was made on the results of the annual examinations written in April 1954. It is not tenable with any other Scholarship.

KENNECOTT COPPER AWARD IN INDUSTRIAL ENGINEERING

Kennecott Copper Corporation offers an Annual Award in Industrial Engineering of the value of $1,000. The recipient of the Award must:

(*a*) be registered in the Second, Third or Fourth year of the course in Industrial Engineering;

(*b*) have attained Honours in the final examinations of the previous year;

(*c*) show qualities of leadership and initiative.

The financial need of the student may be taken into consideration.

Application should be made to the Secretary of the Faculty by October 30.

KIMBERLY-CLARK CORPORATION OF CANADA LIMITED SCHOLARSHIPS

Kimberly-Clark Corporation of Canada Limited has presented two scholarships of a value of $500 each and each scholarship is acompanied by a grant of $100 to the general funds of the University. One scholarship is awarded to an outstanding student of the First Year and one to an outstanding student of the Second Year as indicated by the examination results of their respective years. Students in all courses of the First and Second Years are eligible.

The First awards were made on the results of the annual examinations for 1957–58.

THE LEONARD FOUNDATION SCHOLARSHIPS

Leonard Foundation Scholarships are awarded each year to selected students in Universities and Colleges across Canada, including the University of Toronto. The Trust Deed states: "Preference in the selection of students for scholarships shall be given to the sons and daughters respectively of the following: (*a*) clergymen, (*b*) school teachers, (*c*) officers, non-commissioned officers and men, whether active or retired, who have served in Her Majesty's military, naval or air forces, (*d*) graduates of the Royal Military College of Canada, (*e*) members of the Engineering Institute of Canada, (*f*) members of the Mining and Metallurgical Institute of Canada."

All applicants must be nominated by a member of the General Committee. The latest date for the receiving of applications is March 31, for the following academic year. Further information regarding the procedure to be followed in applying for these scholarships may be obtained by writing to Dr. W. E. Taylor, Honorary Secretary, The Leonard Foundation, c/o Toronto General Trusts Corporation, 253 Bay Street, Toronto.

THE LEVER BROTHERS SCHOLARSHIPS

Lever Brothers Limited have established two Scholarships of $300 each in the Department of Chemical Engineering. The Scholarships will be awarded to a student of the Second Year and to a student of the Third Year in Chemical Engineering to be held in the Third and Fourth Years respectively. The award is based on outstanding scholarship at the annual examinations.

The first awards were based on the annual examinations of 1957.

THE J. EDGAR MC ALLISTER FOUNDATION

Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1891, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mining, Mechanical, Chemical, Electrical and Metallurgy and Materials Science. Inquiries should be made in the Faculty Office.

THE JOHN WOLFE MC COLL MEMORIAL AWARDS

These six awards, two of which are open to students in the Faculty of Applied Science and Engineering, are the gift of the estate of the late John Wolfe McColl. The awards have a minimum value of $250 and a maximum of $750. Applicants must have obtained First Class Honours at the final examinations of the preceding year, whether Ontario Grade XIII or at the University of Toronto, demonstrate financial need and be enrolled or undertake to enrol in either Engineering Science or Chemical Engineering. Students seeking first admission to the University must submit applications for an award to the Registrar of the University on or before May 1. Students in the University must submit applications for an award to the Registrar of the University on or before October 15.

THE J. A. D. MC CURDY PRIZE

The J. A. D. McCurdy Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44) in honour of John Alexander Douglas McCurdy, a graduate of the School of Practical Science, who "made the first flight in Canada on February 23, 1909, with a heavier-than-air machine."

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in annual examinations of the Third Year in the subjects related to Aerodynamics.

The first award was made on the results of the examinations of the Session 1953–54.

THE GARNET W. MC KEE-LACHLAN GILCHRIST SCHOLARSHIP IN ENGINEERING SCIENCE

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a Scholarship in the First Year of the Course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual examinations of the First Year in the Course in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in honours in the Course. In order to receive payment the winner must register in the Second Year of the Course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations of 1947.

THE GARNET W. MC KEE-LACHLAN GILCHRIST GEOPHYSICS SCHOLARSHIPS

Financial assistance was received by Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, from certain organizations and individuals to help him in the prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. To this fund have been added additional amounts received from the estate of the late Garnet W. McKee and from the Hollinger Consolidated Gold Mines Ltd. They are awarded by the Senate, on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the Annual Examinations of 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $190 is awarded to the student in the Second Year in the Course of Engineering Science who obtains the highest aggregate standing at the examinations of the First and Second Years in the Course, provided always that the student obtains honour standing at the examinations of the Second Year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $140 is awarded to the student in the Second Year in the Course of Engineering Science who, of those students who elect to proceed in the Third Year in the Geophysics Option of the Course, obtains the highest aggregate standing at the examinations of the First and Second Years, provided always that the student obtains honour standing at the examinations of the Second Year, and excluding always the student to whom the First Lachlan Gilchrist Geophysics Scholarship has been awarded.

If in any year there is no student who has fulfilled the conditions as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second Year in the Course in Engineering Science who obtains the second highest aggregate standing

at the examinations of the First and Second Years of that Course, provided always that such student obtains honour standing in the examinations of the Second Year.

THE ALEXANDER MAC LEAN SCHOLARSHIP

This scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A. (1908) who retired in 1954. The scholarship, of the value of $250, is awarded to a student in the Third Year of Geological Sciences, Faculty of Arts, or in the Third Year of Geological Engineering, Faculty of Applied Science and Engineering, who, obtaining not less than 75% in the work of the year, obtains the highest standing in the geological subjects common to the two courses.

The first award was made in 1955.

MAC LENNAN-MAC LEOD MEMORIAL PRIZE

The Graduating Class of 1910 has donated an annual prize, known as "The MacLennan-MacLeod Memorial Prize", in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug. MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of $25, is awarded to the First Year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual written examinations; or, in the event of more than one student obtaining equally high rank in Calculus, the award is made to the one of these who also has the highest standing in some other subject common to the competitors, such as Analytical Geometry, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in a subsequent year.

CHARLES GORDON MANNING PRIZE

The Charles Gordon Manning Prize was established by a bequest under the Will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the Prize.

The recipient must be enrolled in the Second Year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations specified for the award of

that Scholarship, namely, obtaining honours in his final examinations and being one of the first three in his year by his standing at those examinations relative to the pass requirements in his Department and being "adjudged highest of the three in general student activities and service in the University during his period of attendance."

The first award was made on the results of the Annual Examinations of 1954.

MARSLAND ENGINEERING LIMITED SCHOLARSHIP

The Marsland Engineering Limited Scholarship, the gift of Marsland Engineering Limited, has a value of $250. It is awarded to the student who, having been granted a Dominion-Provincial Student Aid Bursary in his First Year, is registered in Mechanical or Electrical Engineering and obtains the highest average percentage of marks, with honours, at the annual examination of the First, Second or Third Years in the session in which the award is made.

The first award was made at the annual examinations of 1954.

MASSEY-FERGUSON LIMITED SCHOLARSHIPS

Massey-Ferguson Limited has established two scholarships each of an annual value of $250, to be awarded on the recommendation of the Council of the Faculty of Applied Science and Engineering to students registered in the Fourth Year of the Courses in Mechanical Engineering or Industrial Engineering. In making the award academic achievement, financial need, extra-curricular activities and such other factors as may be deemed appropriate will be taken into consideration.

Application should be made to the Secretary of the Faculty not later than October 15.

JAMES L. MORRIS MEMORIAL PRIZE

The James L. Morris Memorial Prize is the gift of Mrs. J. H. Craig and Mr. J. R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career. Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For 43 years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal, power and bridge work.

This Prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second Year in the Course in Civil Engineering who obtains the highest aggregate percentage at the annual examinations of the First and Second Years of the course, provided always that the student obtains honour standing at the Examinations of the Second Year.

NORTHERN ELECTRIC UNDERGRADUATE SCHOLARSHIP

The Northern Electric Company Limited have established a Scholarship in the Faculty of Applied Science and Engineering and the Faculty of Arts of an annual value of $500. In this Faculty the scholar must be registered in the First, Second or Third Year of Electrical Engineering, Mechanical Engineering, Engineering Science or Industrial Engineering. He must also (*a*) be a Canadian citizen or landed immigrant and (*b*) have a minimum of 75% or its equivalent in the previous annual examinations, in this or another recognized University. This scholarship is not tenable with other awards from commercial sources, or with awards stipulating subsequent employment as a condition (e.g. R.O.T.P.).

The award is made alternately in the two faculties, the first in the Faculty of Arts in 1959 and in the Faculty of Applied Science and Engineering in 1960 and in a similar manner thereafter. Application is not required.

THE ONTARIO HOCKEY ASSOCIATION WAR MEMORIAL SCHOLARSHIP

The Ontario Hockey Association War Memorial Scholarship, the gift of the Ontario Hockey Association, is to be awarded annually at the Grade XIII examination to an applicant whose father served overseas with the Canadian Forces in World War I.

The value of this scholarship is $100 in cash, with an allowance of the same amount on the tuition fee for each session.

In determining the award of the scholarship, the academic qualifications of the candidate shall be first taken into account, provided always that no candidate shall be eligible for an award who has not met all the conditions required by the University of candidates for admission scholarships generally; but, *cæteris paribus*, the award shall be made to a student who is in proved need of assistance.

The award shall be made by the Senate of the University upon the report of a committee to be appointed by the Senate, upon which committee there shall be always one member of the Staff of the University who shall be deemed to be the representative of the Association.

Application should be made to the Registrar of the University on the regular scholarship application form not later than May 1.

ONTARIO MUNICIPAL ELECTRIC ASSOCIATION BURSARY

District No. 4 of the Ontario Municipal Electric Association has provided a Bursary of $300 in the Faculty of Applied Science and Engineering.

An applicant for the Bursary must:

(*a*) be registered in the Fourth Year, Electrical Engineering;

(*b*) have good academic standing;

(*c*) be in need of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

PAULIN MEMORIAL SCHOLARSHIP

The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a graduate of this Faculty in 1907, was established in memory of his brother, John Cameron Paulin, a student of this Faculty, who was fatally injured in 1906 during a football practice. The scholarship, which has the value of the income from a capital fund of $10,000, approximately $425 annually, is awarded to a student who obtains high standing in the work of the first year in the Faculty of Applied Science and Engineering.

PROCTER AND GAMBLE BURSARY PLAN

Procter and Gamble Bursaries, the gift of the Procter and Gamble Company of Canada, are awarded annually to students in all years. Applicants must have at least Second Class Honours or better in the final examinations of the preceding year and demonstrate financial need. Applications must be submitted to the Registrar of the University on or before December 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO ADMISSION SCHOLARSHIP

The Association of Professional Engineers of the Province of Ontario has established an Admission Scholarship in Engineering of the value of $500. It is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Application must be made to the Registrar before May 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO SCHOLARSHIPS

The Association of Professional Engineers of the Province of Ontario offers Scholarships of a value of $250 in each of the First, Second and Third Years in the Faculty of Applied Science and Engineering in any course, to the students who, taking Honours, obtain the highest standing in the work of their respective years.

These scholarships will not be awarded to students who hold other scholarships.

PROFESSIONAL ENGINEERS GOLD MEDAL

The Association of Professional Engineers of the Province of Ontario has established in the Faculty of Applied Science and Engineering an award in the form of a gold medal accompanied by a gift of technical books of an approximate value of $50. The award will be made to the student of the final undergraduate year in any course who, taking honours, obtains the highest weighted average percentage in the practical work and written examinations of the year.

RANSOM SCHOLARSHIP IN CHEMICAL ENGINEERING

The Ransom Scholarship in Chemical Engineering is presented by A. C. Ransom, Esq., of Toronto, for the purpose of encouraging and giving financial assistance to students who choose the field of Chemical Engineering. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount such as will be derived from the income of this sum. The first award was made on the results of the annual examinations of 1938.

The scholarship will be awarded annually to the student registered in the Course in Chemical Engineering who obtains the highest aggregate percentage of marks in the examinations of the First Year. The scholarship will be paid to the winner only if he proceeds to take his Second Year in the Course in Chemical Engineering in the University of Toronto.

THE RHODES SCHOLARSHIP

The Rhodes Trustees offer for award in the Province of Ontario two out of ten of the Rhodes Scholarships for Canadians, each of the value of £900 and tenable at Oxford University for a period of two years; in certain cases, a third year may be authorized.

Each candidate must be a British subject with at least five years domicile in Canada and unmarried; he must have passed his nineteenth but not his twenty-fifth birthday on October 1 of the year *for* which he is elected; he must have completed the first year and have entered upon the second year of his course at a Canadian university at the time of application.

A candidate may apply either for the province in which he has his private home or residence, or for the province in which he has taken his university course.

In that section of the will in which he defined the general type of scholar he desired, Mr. Rhodes mentioned four groups of qualities, the first two of which he considered most important.

(1) Literary and scholastic attainments;

(2) Qualities of manhood, truth, courage, devotion to duty, sympathy, kindliness, unselfishness, and fellowship;

(3) Exhibition of moral force of character and of instincts to lead and to take an interest in his fellows;
(4) Physical vigour, as shown by fondness for and success in outdoor sports.

Some definite quality of distinction, whether in intellect, character or personality, or in any combination of these, is the most important requirement. Financial need does not receive special consideration.

Forms of application and full information regarding these scholarships may be obtained from the Registrar, University of Toronto, or from the secretary of the Ontario Selection Committee, Alistair W. Gillespie, Esq., Suite 1602, 50 King St. W., Toronto. Selection is made in December for the following year and all applications must reach the provincial secretary before November 15 annually.

R.C.E. MEMORIAL SCHOLARSHIP

The Memorial Fund Committee of the Royal Canadian Engineers has established the R.C.E. Memorial Scholarship of a value of $125, open to students who have successfully completed their second to last year in the Faculty of Applied Science and Engineering or the School of Architecture.

A candidate must be

(*a*) a member in good standing of the Canadian Officers Training Corps and have successfully completed one summer season's training

or

(*b*) an ex-member of the Canadian Officers Training Corps who has successfully completed two years of C.O.T.C. Training and has transferred to the Canadian Army (Militia) or to the Canadian Army (Supplemental Reserve)

or

(*c*) a member of the Canadian Army (Regular) attending University under the Regular Officers Training Plan.

Selection is made on the basis of academic standing and of qualities of leadership.

Application forms may be obtained from the office of the Registrar.

REGULAR OFFICER TRAINING PLAN

Tenable in approved degree courses, this plan is available to Canadian citizens or British Subjects resident in Canada, who undertake to serve in the armed forces for at least four years after graduation. Accepted candidates will receive tuition, a book allowance of $75.00 and a living allowance of $143.00 per month during the academic session.

Application should be made to the Resident Staff Officer, 119 St. George Street, Toronto 5, or to the Canadian Forces Recruiting Centre, 25 St. Clair Avenue East, Toronto 7.

HELEN E. ROGERS ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of Helen E. Rogers open to students entering any degree course in the University. Preference is given to applicants from outside Ontario but failing such candidates awards may be made to qualified Ontario students. Recipients must have a standing satisfactory to the Committee of Award on first admission and may continue to enjoy the scholarship in the upper years provided they maintain first class standing. The value in each year is a minimum of $200 and a maximum of $1,500 dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

FREDERICK W. SCHUMACHER SCHOLARSHIP

The Frederick W. Schumacher Scholarship has been established in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must (*a*) be enrolled in the Second, Third or Fourth years in Mining Engineering or Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and (*b*) must have high academic standing.

Applications must be submitted to the University Registrar not later than October 15.

THE SCOTTISH RITE MASONS' BURSARY

The Scottish Rite Masons' Bursary, the gift of the Scottish Rite Masons of Toronto, of the value of $400 is awarded to a student enrolled in the Second Year who is a member of the Masonic Order, or a son, brother, nephew, daughter, sister or niece of a member of the Masonic Order. Consideration will be given to financial need and academic standing. Evidence of connection with the Masonic Order and information regarding financial need must be given with the application which must be submitted to the Secretary of the Faculty on or before October 15.

"SECOND MILE ENGINEER" AWARD

The Class of 3T5, convinced that a successful engineer must not only be professionally competent but also constantly aware of his responsibilities to humanity, and inspired by an address of President William E. Wickenden of the Case School of Applied Science, Cleveland, called "The Second Mile", which was based on the text from the Sermon on the Mount, "whosoever shall compel thee to go one mile, go with him twain" has established the "Second Mile Engineer" award. It is the desire of the donors to encourage undergraduates to participate fully in extra-curricular activities and to recognize the true importance of the more

liberal subjects of the curriculum with the ultimate objective, on entering their profession, of becoming worthy Second Mile Engineers. The award comprises a grant of $200, a suitably inscribed presentation piece and an illuminated scroll, and is presented to a student in his final year.

An eligible group is chosen from those who have taken a prominent part in the affairs of the Faculty, either as office holders or in athletics. In making the award consideration is given to academic standing, with special emphasis on the candidate's attainments in the cultural and humanistic-social studies. The subjects which are stressed are English of the First Year; Economics of the Second Year; and Political Science and Modern World History of the Third Year.

Particulars are furnished each session by the Class of 1935.

THE SIMPSONS-SEARS LIMITED (NORTHERN ONTARIO) SCHOLARSHIPS

These scholarships, the gift of Simpsons-Sears Limited, are open only to students of the Copper Cliff High School, The Sudbury High and Technical Schools, the Sturgeon Falls High School, the North Bay Collegiate Institute and Vocational School, the Kapuskasing High School and all the Secondary Schools along the Ontario Northland Railway. A scholarship of the value of $100 is available for each of the schools mentioned and an additional sum of $50 will be given to the student who obtains the highest percentage of the nine papers of Grade XIII selected in accordance with the regulations.

No scholarship will be awarded unless the candidate is in actual attendance in one of the colleges or faculties of the University and maintains a uniformly high standard to the satisfaction of the donors of the scholarships.

Application for these scholarships must be sent not later than May 15, to the Principal of the North Bay Collegiate Institute and Vocational School, from whom further information may be obtained regarding conditions of award.

SMITH AND STONE LIMITED BURSARIES

Smith and Stone Limited, Georgetown, Ontario, have provided five Bursaries, each of a possible value of $600 and each payable at the rate of $150 per year to assist deserving students from the Georgetown High School.

The award is made annually by the Senate on the recommendation of the Council of the Faculty to a student:

(*a*) who attended Georgetown High School for at least 2 years and is recommended by the Principal;

(*b*) who has met in full the admission requirements of the Faculty, first-class honours not being a requirement.

To be eligible for continued enjoyment of the Bursary the holder must maintain satisfactory academic standing but not required to obtain honour standing.

The award was offered for the first time in the Session 1952–53.

SOCIETY OF AUTOMOTIVE ENGINEERS PRIZE

The Ontario Section of the Society of Automotive Engineers offers an annual prize of the value of $100 to a student of the Fourth Year in any course whose thesis on a topic related to Automotive Engineering is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory.

SOCIETY OF CHEMICAL INDUSTRY MERIT AWARD

The Society of Chemical Industry Merit Award is made annually by the Society to the student in Fourth Year in the Department of Chemical Engineering who obtains the highest weighted average of marks in the results of the annual examinations for the year. The award is a gold key.

THE MURRAY F. SOUTHCOTE SCHOLARSHIP

Established by friends of the late Murray F. Southcote, a graduate of this Faculty (Aeronautical Engineering, 1950) this scholarship, which has a value of $100, is awarded in recognition of high standing at the Annual Examinations of the Third Year, in any course in the Faculty.

The first award was made in the Session 1964–65.

THE SPECIFICATION WRITERS ASSOCIATION SCHOLARSHIP IN CIVIL ENGINEERING

Donated by the Toronto Chapter of the Specification Writers Association of Canada, this scholarship has a value of $250 and is awarded to a student who achieves high standing, with honours, in the annual examinations of the Third Year in Civil Engineering.

The first award of this scholarship was made in the Session 1961–62.

SPRUCE FALLS POWER AND PAPER COMPANY LIMITED SCHOLARSHIPS

The Spruce Falls Power and Paper Company Limited has established four Scholarships of a value of $400 each, two in the Second Year and two in the Third Year. They are awarded on the results of the Annual Examinations of the Second and Third Years to the students who obtain honour standing at the examinations of their respective years and are open to students in all courses in the Faculty. The first awards were made on the results of the examinations of 1951.

Each scholarship carries a grant of $150 to the University General Funds.

WALTER STERLING ADMISSION SCHOLARSHIPS

Established in memory of Walter Sterling, these scholarships are open to students entering any first degree course at the University of Toronto. Recipients must obtain First Class Honours standing on the nine Ontario Grade XIII papers required for admission, and may continue to enjoy the scholarships in each year of their course providing they maintain Honour standing. The value of the scholarship is from $200 to $1,500

annually, dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University on the regular scholarship application form. The statement of financial need should be completed if an award greater than $200 is desired.

THE WILLIAM STORRIE MEMORIAL SCHOLARSHIPS IN CIVIL ENGINEERING

Three Scholarships have been established by Mrs. William Storrie in memory of her husband, the late William Storrie, a Consulting Engineer on many municipal projects in Canada and for several years a special lecturer in the Faculty of Applied Science and Engineering, for students in Civil Engineering, as follows:

(*a*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Second Year in Civil Engineering.

(*b*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Third Year in Civil Engineering.

(*c*) Of a value of $200 to the student who obtains the highest standing in the annual examinations of the Fourth Year in the Municipal and Sanitary Option of the course in Civil Engineering.

In all cases the candidates shall have demonstrated qualities of integrity and shown promise of leadership in their profession.

The first awards were made for the Session 1956–57.

THE TRANE COMPANY OF CANADA LIMITED PRIZE

The Trane Company of Canada Limited has established an annual Prize of $200 in the Faculty of Applied Science and Engineering. The recipient may be registered in the Fourth Year in any course and the Prize will be awarded for the best Thesis on air-conditioning or refrigeration, either for comfort cooling or industrial use.

This award is tenable with other awards in the gift of the Senate. Application is not required.

EDITH TYRRELL MEMORIAL BURSARY

The Women's Association of the Mining Industry of Canada has presented this Bursary, having the value of $600, annually, commencing in 1939, and named in memory of their founder and first president, Mrs. Edith Tyrrell. A medal donated by Dr. Tyrrell accompanies the Bursary. The Bursary is awarded to a student entering the Third or Fourth Year in the Course in Mining Engineering, Metallurgy and Materials Science, or Geological Engineering; it may be awarded two years in succession to the same student, but will usually be awarded at the beginning of the Third Year. The award will be made by a special committee appointed by the Association on the following basis:

(*a*) In addition to mental capacity, the student must show leadership

ability and give promise, through his activities, of becoming a worthwhile influence in the affairs of the profession and the community.

(*b*) While attention is given to scholastic ability, as evidenced by his academic standing, it is not the governing factor. He must, however, stand in the top quarter of his class.

(*c*) Special consideration is given to financial need.

Application must be made to the Secretary of the Faculty within one month of the opening of the academic year.

S. UBUKATA FUND

The S. Ubukata Fund for Japanese students was established to assist students from Japan proper to pursue a course of study at the University of Toronto. The fund provides grants of varying values on the basis of the information submitted by the applicants who:

(i) must be Japanese students from Japan proper;
(ii) must register in the University of Toronto devoting full time to their studies;
(iii) are able to satisfy admission requirements regarding English facility;
(iv) are not holding other financial aid.

UNIVERSITY OF TORONTO ALUMNI ASSOCIATION WAR MEMORIAL SCHOLARSHIPS

Six scholarships are awarded annually by the University of Toronto Alumni Association to students entering first degree courses at the University of Toronto. The scholarships have a value of $500 annually, and are tenable for two years, providing satisfactory academic standing is maintained. They are awarded for general proficiency in Grade XIII, and in addition to academic performance the committee of award will take into consideration the candidate's relationship to active service in the Armed Forces of Canada, need of financial assistance, participation in extra-curricular activities and such other qualifications as may commend themselves to the committee. One scholarship will be available to a student whose home is not in the Province of Ontario.

Students resident in Ontario may apply on the general admission scholarship form which must be submitted to the Registrar of the University not later than May 1. Evidence of relationship to active service in the Armed Forces of Canada should be attached. Students resident outside Ontario may obtain the necessary forms from the Awards Department, Office of the Registrar, University of Toronto.

UNIVERSITY OF TORONTO CHEMICAL ENGINEERING CLUB SCHOLARSHIP

Provided by the University of Toronto Chemical Engineering Club, this scholarship has a value of $150 and is awarded to a student who obtains high standing in the work of the Second Year in Chemical Engineering. It is tenable only in the Third Year of the course in Chemical Engineering and may not be held with any other scholarship.

UNIVERSITY NAVAL TRAINING DIVISION BURSARIES

The University Naval Training Division Bursaries, the gift of the University Naval Training Division, are of the value of $100 each. As many as three bursaries may be awarded in each session; if fewer than three are awarded those not awarded may be given in a subsequent session. A candidate must be registered in the University for a full-time course leading to a diploma or degree and must be at the time of the award a member of one of the recognized military training units within the University. Application must be made to the University Registrar before the end of November.

UNIVERSITY OF TORONTO GENERAL BURSARIES

The Board of Governors has established a fund to provide bursaries for deserving students who without financial assistance cannot continue their formal education. Further information may be obtained from the Secretary of the Faculty.

THE U.T.S. ENGINEERING SCHOLARSHIP

The U.T.S. Engineering Scholarship, the gift of R. A. Bryce, Esq., of the value of $250. The scholarship will be awarded by a committee of the Staff of the University of Toronto Schools to a student of the Schools who has completed the requirements for admission to and enrols in the Faculty of Applied Science and Engineering.

WALLBERG ADMISSION SCHOLARSHIPS

Two admission scholarships, each of a value of $500 are awarded annually from the income from the Wallberg Bequest on the recommendation of the Council of the Faculty to the two candidates who obtain the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that this attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Applications must be submitted to the Registrar on the prescribed form by May 1.

WALLBERG UNDERGRADUATE SCHOLARSHIPS

These scholarships, four in number, of the value of $500 each, derived from the Wallberg Bequest, are awarded annually; two to students ranking first and second respectively at the annual examinations of the First Year; one to the student ranking first at the annual examinations of the Second Year; and one to the student ranking first at the annual examinations of the Third Year.

Any holder of one of these scholarships may not hold other awards listed in the index with an asterisk. The awards were first made on the result of the annual examination of 1947.

W. S. WILSON MEDALS

These medals have been provided in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal will be awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of his course.

The first awards were made in the Session 1962–63.

WILLIAM R. WORTHINGTON MEMORIAL SCHOLARSHIP

The William R. Worthington Memorial Scholarship, the gift of Miss Ida R. Worthington, in memory of her brother, William R. Worthington, Dip.(1904), B.A.Sc.(1905), of the value of the income from a fund is awarded annually to the student of the Second Year in the course in Civil Engineering who ranks highest at the annual examinations of that year.

The first award was made at the examinations for the Session 1954–55.

LOAN FUNDS

From the loan funds mentioned below, small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must accordingly be restricted, both in amount and number, and principally to students in the Third and Fourth Years.

Enquiries for loans from any of the following funds should be made at the office of the Secretary of the Faculty.

Engineering Alumni Loan Fund
Engineering Society Loan Fund
Elizabeth Speller Memorial Fund
James W. Crocker Memorial Fund
Harry F. Bennett Educational Fund
S.A.E.—Canadian Section Loan Fund
Class of 2T7 (SPS) Memorial Loan Fund
Avro Aircraft Limited Engineering Loan Fund
Association of Professional Engineers Loan Fund

The William Storrie Memorial Fund
3T6 Engineers Loan Association
4T0 Engineering Loan Fund
Women's Association of the Mining Industry in Canada Loan Fund
The Devonshire Loan Fund
Class of '09 Trust Fund
University of Toronto Alumni Loan Fund
University of Toronto General Loan Fund

CLASS OF 1936 LOAN ASSOCIATION

Members of the Class of 1936 have made arrangements to assist students in obtaining loans through regular banking facilities. Information may be obtained from the Secretary of the Faculty.

ENGINEERING ALUMNI LOAN FUND

The Engineering Alumni Association established in 1950 a loan fund to assist engineering students, especially in the Third and Fourth Years.

Applications for loans from this fund should be made to the Secretary of the Faculty.

CLASS OF 2T7 (SPS) MEMORIAL LOAN FUND

This fund was established in 1955 to memorialize the Class of 1927 of the Faculty of Applied Science and Engineering.

Loans to a total of $250 are available to any undergraduate who has completed one Year, with or without conditions, and who has qualified for the Second, Third or Fourth Year.

Application shall be made to the Secretary of the Faculty.

ENGINEERING SOCIETY LOAN FUND

In 1932 the Engineering Society repaid to the Board of Governors a series of annual grants which, over a period of years, had been made to the Society for special purposes. The Board of Governors, appreciating this action, set aside this sum, to be known as the Engineering Society Loan Fund, to provide loans to students of the Faculty of Applied Science and Engineering. The administration of the fund is carried out by a Committee appointed by the Board. The fund is not large, and only small loans can be made to relatively few students. Further inquiries should be made at the office of the Secretary of the Faculty.

ELIZABETH SPELLER MEMORIAL FUND

Through the generosity of Dr. F. N. Speller, of the Class of 1893, the "Elizabeth Speller Memorial Fund" has been established to provide loans for worthy students of the Third and Fourth Years of this Faculty. Applications for loans from this Fund should be made to the Secretary of the Faculty.

JAMES W. CROCKER MEMORIAL LOAN FUND

This fund was established by Mrs. William Crocker in memory of her son, James W. Crocker, a graduate in Mining Engineering in 1938, who was killed in an accident in a mine in the same year.

HARRY F. BENNETT EDUCATIONAL FUND

This fund was established by subscription from members of The Engineering Institute of Canada in memory of the late Harry F. Bennett, M.E.I.C., who for six years prior to his death in 1946 was chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, and who accomplished so much in this field by untiring efforts.

One purpose of the fund is to make loans to deserving students who need financial assistance to enable them to study engineering sciences at university level, and who have proved themselves by successfully completing their first year in engineering or the equivalent.

Loans will be made largely on the basis of character and to men who seem likely to develop the high professional standards which are essential to leadership in engineering science. A student who has been aided by this fund should feel that high obligations are placed on him; obligations to the subscribers, to the trustees, and to those coming after him who in turn can receive help as his loan is repaid.

Application forms may be obtained at the Faculty Office. The regulations are simple and the application of any worth-while student will be given immediate and careful attention.

SOCIETY OF AUTOMOTIVE ENGINEERS—CANADIAN SECTION LOAN FUND

The Society of Automotive Engineers—Canadian Section has established a loan fund of $1,200 in the Faculty of Applied Science and Engineering. Preference is given to students in good scholastic standing and engaged in studies relative to the automotive and aircraft industries, and to students in fourth, third and second years in that order. Particulars may be obtained from the Secretary of the Faculty.

AVRO AIRCRAFT LIMITED ENGINEERING LOAN FUND

Avro Aircraft Limited has established a Loan Fund of $3,000 to provide loans to engineering students requiring financial assistance. Application should be made to the Secretary of the Faculty.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO LOAN FUND

The Association of Professional Engineers has made loans not exceeding $200 available to students in the First, Second and Third Years in this Faculty. Application should be made to the Association at 236 Avenue Road, Toronto.

THE WILLIAM STORRIE MEMORIAL FUND

The William Storrie Memorial Fund has been established by Mrs. William Storrie to provide loans to undergraduates in the course in Civil Engineering. Application should be made to the Secretary of the Faculty.

THE DEVONSHIRE LOAN FUND

This Fund has been established by Graduates and friends of Devonshire House to assist students in the Residence. Application should be made to the Office of the Dean of Devonshire House.

CLASS OF '09 TRUST FUND

The Class of '09 on the 50th Anniversary of their graduation made a sum of money available in the Faculty for financial aid to undergraduates, with preference to Second Year students. Inquiry should be made to the Secretary of the Faculty.

THE UNIVERSITY OF TORONTO ALUMNI LOAN FUND

This fund comes from subscriptions received originally in 1919 and in succeeding years from graduates of the University and is administered by the University of Toronto Alumni Association.

Loans are available to undergraduate and graduate students enrolled in a full time course at the University, in second and subsequent years.

Particulars may be obtained from The University of Toronto Alumni Association, Alumni House, 18 Willcocks Street, Toronto, or from the Secretary of the Faculty or School.

SECTION XI. DISCIPLINE

A SUMMARY OF THE REGULATIONS OF THE CAPUT CONCERNING STUDENT DISCIPLINE

1. Subject to the general regulations of the Caput of the University regarding jurisdiction in matters of discipline the Council of University College, the governing bodies of the Federated Universities and Affiliated Colleges, and the Councils of the Faculties, Schools, and Institutes have disciplinary jurisdiction over the conduct of all students registered in these Divisions of the University in all matters of local or internal concern to these Divisions. Jurisdiction over the conduct of students while in residence regardless of the Division of the University in which they are registered is vested in the body administering the residence.

2. Jurisdiction concerning conduct likely to affect the interests of the University as a whole is vested in the Caput.

3. The Students' Administrative Council will be supported in the proper performance of all its obligations and duties as provided in its Constitution.

4. Where the appropriate body exercising disciplinary jurisdiction has found that a student of the University has engaged in conduct prejudicial to the interests of the University, the Caput may, in its discretion, suspend or expel such student from the academic privileges of the University. Every decision of the Caput involving the expulsion of a student from the University requires confirmation of the Board of Governors.

5. Any student who interferes with the personal liberty of another or who subjects another student to indignity or personal violence may be considered by the Caput or any other body exercising disciplinary jurisdiction in the University to have committed a breach of discipline.

6. Initation ceremonies involving physical violence, personal indignity, interference with personal liberty, or destruction of property, may be deemed a breach of discipline by the Caput or any other body exercising disciplinary jurisdiction in the University.

7. Without limiting the disciplinary powers vested in the respective bodies exercising disciplinary jurisdiction as set forth in sections 1–7, the following are cited as illustrations of conduct which, in the past, has been considered a breach of discipline prejudicial to the interests of the University:

(i) The organising of a parade on the streets of the city or the taking part in such a parade without permission of the authorities.

(ii) The destruction or defacing of University property, raids on Residences or other University buildings, and the breaking into University buildings.

(iii) Rowdy and other forms of behaviour, either on or off the Campus, of such an objectionable nature as to bring the University into public disrepute.

8. Student Clubs and Associations

(a) The constitution of every society or association of students in the University and all amendments to such constitutions require to be approved by the relevant University authorities. The giving of approval, and the responsibility for the programmes of student societies and associations, shall rest as follows:

(i) With the authorities of the College, Faculty or School concerned where the membership of the student society or association is drawn from a single College, Faculty or School.

(ii) With the Board of Stewards of Hart House, where the student society or association is a Committee of Hart House and is controlled by the Board of Stewards of Hart House.

(iii) With the Caput, in the case of all other student societies and associations.

(b) No approval will be given by any of the authorities listed in (a) above to the constitution of any society or association of students if that constitution permits:

(i) Membership in the society or association to persons who are not students of the University, unless in the case of the societies listed in (a) (ii) above, where membership is open also to graduates of the University and members of the Faculty of the University.

(ii) Any action of discrimination based upon race, religion, or colour.

9. The name of the University is not to be used in connection with a publication of any kind without permission of the Caput.

SUMMARY OF STUDENTS IN ATTENDANCE

Session 1965–66

Courses		1	2	3	4	5	6	7	8	9	Total
Year	I	61	—	72	43	73	111	98	10	11	479
	II	66	—	56	52	51	98	85	13	8	429
	III	42	2	69	46	45	82	85	8	9	388
	IV	49	9	47	35	43	50	58	16	4	311
TOTAL		218	11	244	176	212	341	326	47	32	1607
Special Students											9
Diploma Course in Operations Research											9
											1625

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UNIVERSITY OF TORONTO

CALENDAR



Faculty of Applied Science and Engineering

1967-1968

UNIVERSITY OF TORONTO PRESS
1967

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Jan.

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FALL TERM, 1967

July 1	*Saturday*	Dominion Day. Buildings closed.
August 7	*Monday*	Civic Holiday. Buildings closed.
August 14	*Monday*	Students of the III Year, Course 1, report at Survey Camp.
August 21	*Monday*	Students of the IV Year, Course 1, Option B, report at Survey Camp.
September 4	*Monday*	Labour Day. Buildings closed.
September 5	*Tuesday*	Fall Examinations commence.
		Students of the III Year, Course 9, report at Survey Camp.
September 6	*Wednesday*	Students in II Year, Course 6, report for Analytical Chemistry Laboratory.
September 14	*Thursday*	Registration in person of the I Year from 9:30 a.m. to 12 noon and from 2:00 p.m. to 4:30 p.m. in the Galbraith Building.
		Meeting of Faculty Council.
September 15	*Friday*	Registration in person of the II Year from 9:30 a.m. to 12 noon and of the III Year from 2:00 p.m. to 4:30 p.m. in the Galbraith Building.
		Dean's address to the I Year at 9:00 a.m. in Convocation Hall.
		Preliminary instruction to the I Year.
September 16	*Saturday*	Registration in person of the IV Year from 9:30 a.m. to 12 noon in the Galbraith Building.
September 18	*Monday*	Lectures and laboratory work commence at 9:00 a.m.
		Opening address by the President to the students of all Faculties at 2:00 p.m. in Convocation Hall. Lectures and laboratory classes withdrawn from 1:45 p.m. to 3:10 p.m.
October 3	*Tuesday*	Meeting of Faculty Council.
October 9	*Monday*	Thanksgiving Day. Buildings closed.
October 13	*Friday*	Meeting of Senate.
November 1	*Wednesday*	Meeting of Faculty Council.
November 10	*Friday*	Remembrance Day Service 10:30 a.m. Lectures and laboratory classes withdrawn from 10:00 a.m. to 11:00 a.m. (11:00 a.m. classes will begin at 11:15 a.m.)
		Meeting of Senate.

November 24	*Friday*	Fall Convocation.
December 1	*Friday*	Meeting of Faculty Council.
December 8	*Friday*	Meeting of Senate.
December 18	*Monday*	First Year Term Examinations commence.
December 20	*Wednesday*	Term ends at 5 p.m.
December 25	*Monday*	Christmas Day. Buildings closed.

SPRING TERM, 1968

January 1	*Monday*	New Year's Day. Buildings closed.
January 3	*Wednesday*	Spring term begins, Mid-session Examinations commence.
January 10	*Wednesday*	Meeting of Faculty Council.
January 12	*Friday*	Meeting of Senate.
January 15	*Monday*	Last day for receiving the second term instalment of fees.
January 18	*Thursday*	IV Year Employment interviews.
January 19	*Friday*	IV Year Employment interviews.
January 20	*Saturday*	IV Year Employment interviews.
February 1	*Thursday*	Meeting of Faculty Council.
February 9	*Friday*	Meeting of Senate.
February 19 to February 24	*Monday* *Saturday*	Study week. Lectures and laboratory classes withdrawn.
March 1	*Friday*	Meeting of Faculty Council.
March 8	*Friday*	Meeting of Senate.
April 1	*Monday*	Meeting of Faculty Council.
April 11	*Thursday*	Term ends at 5 p.m. Meeting of Senate.
April 12	*Friday*	Good Friday. Buildings closed.
April 19	*Friday*	Annual Examinations commence.
May 1	*Wednesday*	Meeting of Faculty Council.
May 10	*Friday*	Meeting of Senate.
May 20	*Monday*	Victoria Day. Buildings closed.
May 27 to June 4	*Monday* *Tuesday*	Convocations.

ADMINISTRATIVE OFFICERS
1966–1967
THE UNIVERSITY

President . . . . . C. T. Bissell, M.A., Ph.D., D.Litt., LL.D., F.R.S.C.
Executive Assistant to the President . . . . . D. F. Forster, B.A., A.M.

Vice-President and Provost . . . . . M. St. A. Woodside, M.A., LL.D.
Vice-Provost . . . . . J. H. Sword, M.A.

Vice-President (Health Sciences) . . . J. D. Hamilton, M.D., F.R.C.P.(C)
Vice-President (Research Administration)
G. de B. Robinson, M.B.E., B.A., Ph.D., F.R.S.C.

Vice-President for Scarborough and Erindale Colleges and Principal of Erindale College D. C. Williams, M.A., Ph.D.

Chief Librarian . . . . . R. H. Blackburn, M.A., B.L.S., M.S., LL.D.

Vice-President (Administration) . . . . . F. R. Stone, B.Com., C.A.
Director of Finance . . . . . G. L. Court, D.F.C., M.Com., C.A.
Secretary of the Board of Governors and Director of Administrative Services . . . . . D. S. Claringbold
Director of Physical Plant . . . . . F. J. Hastie, B.Sc., P.Eng.

Registrar and Director of Student Services . . . . R. Ross, M.B.E., M.A.
Executive Assistant to the Registrar . . . . . W. Kent, M.A.
Director of Admissions . . . . . E. M. Davidson, B.A.
Director of Student Awards . . . . . R. L. Purves, D.S.O., C.D., B.A.
Special Officer (Secondary School Liaison)
J. R. H. Morgan, M.B.E., M.A., B.Paed., LL.D.
Director of Statistics and Records . . . J. H. Tusiewicz, M.A.Sc., M.B.A.
Director of University Health Service G. E. Wodehouse, M.C., M.D., F.R.C.P.
Assistant Director of University Health Service —Women . . . . . Miss F. H. Stewart, B.A., M.D.
Director of Placement Service . . . . . J. K. Bradford, O.B.E., M.A.Sc.
Director of International Student Centre . . . . . Mrs. K. Riddell, B.A.
Director of the Advisory Bureau
D. J. McCulloch, B.A., M.D., D.Psych., F.R.C.P.
Director of Housing Service . . . . . Mrs. M. G. Jaffary, B.A.

Director of University Extension . . . . . G. H. Boyes, M.A.

Director of University of Toronto Press . . . . M. Jeanneret, B.A., LL.D.

Director of Information . . . . . K. S. Edey
Director of Alumni Affairs . . . . . J. C. Evans, B.A.
Director of Development . . . . . R. J. Albrant

Warden of Hart House . . . . . E. A. Wilkinson, B.A.
Director of Athletics and Physical Education —Men . . . . . W. A. Stevens, B.S.
Director of Athletics and Physical Education —Women (Acting) . . . . . Miss D. Jackson, B.A.Sc., M.A.

SECTION III. FACULTY STAFF

1967–68

ADMINISTRATIVE STAFF

Dean . . . . . J. M. Ham, B.A.SC., S.M., SC.D.
Associate Dean . . . . . W. F. Graydon, M.A.SC., PH.D.
Assistant Dean and Secretary . . . . . J. A. Gow, B.A.SC.

TEACHING STAFF

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY:

Professor and Head of the Department: J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.).

Professors: W. F. Graydon, M.A.SC., PH.D.(MINN.); R. E. Jervis, M.A., PH.D.; W. G. MacElhinney, M.A.SC.; W. H. Rapson, M.A.SC., PH.D.; I. H. Spinner, M.A.SC., PH.D.; M. Wayman, M.A., PH.D.; H. L. Williams, B.A., M.SC.(WESTERN), PH.D.(MCGILL); *Professor of Nuclear Engineering*: D. G. Andrews, M.A.(CANTAB.).

Associate Professors: D. Basmadjian, DIP.ING.CHEM.(ZURICH), M.A.SC., PH.D.; W. H. Burgess, B.CH.E., M.F.S., PH.D.(CORN.); M. E. Charles, B.SC.(LOND.), M.SC., PH.D.(ALTA.); R. L. Hummel, B.S. (PURDUE), PH.D.(IOWA); R. W. Missen, M.SC.(QU.), PH.D.(CANTAB.); S. Sandler, M.A.SC.; J. W. Smith, M.A.SC.(U.B.C.), PH.D. (LOND.); O. Trass, B.S.E. (PRINCETON), SC.D.(M.I.T.); *Associate Professor of Mining Engineering*: W. A. M. Hewer, B.A.SC.

Assistant Professors: D. Barham, B.SC.(ENG.), D.I.C., PH.D.(LOND.); R. Luus, M.A.SC., A.M., PH.D.(PRINCETON); D. Mackay, B.SC., PH.D. (GLASGOW).

Lecturers: C. C. Barnes, B.SC.(QU.); J. Binkiewicz, DIP.CHEM.ENG. (LWOW); Z. May, DIP.ING.CHEM.(WARSAW); Miss M. J. Phillips, B.A.SC., M.A.(BRYN MAWR), PH.D.(J.H.U.); A. Rozeiu, DIP.CHEM.ENG. (BUCHAREST).

Special Lecturer: C. P. Brockett, B.SC.(M.I.T.).

DEPARTMENT OF CIVIL ENGINEERING:

Professor and Head of the Department: C. F. Morrison, B.E.(SASK.), M.SC.(MCG.).

Professors: C. E. Helwig, m.a.sc.; M. W. Huggins, m.a.sc.; G. Kani, dr.ing.(stuttgart); O. J. Marshall, b.a.sc., c.e., o.l.s.

Associate Professors: J. D. Barber, c.d., m.a.sc.; A. P. Bernhart, dip. ing.(graz.), dr.tech.(graz.); R. A. Collins, b.a.sc., m.s.(ill.), ph.d.(ill.); A. C. Davidson, b.sc., c.e., b.sc., e.e.(man.), m.a.sc.; M. M. Davis, b.sc.(qu.), m.sc.(purdue); F. A. De Lory, b.eng. (mcg.), m.a.sc., d.i.c.(imp.), ph.d.(lond.); H. R. Frizzle, b.sc., e.e.(n.s.tech.); B. J. Haynes, b.a.sc., o.l.s.; C. Hershfield, b.sc., c.e.(man.), m.a.sc.; D. J. L. Kennedy, b.a.sc., m.s.(ill.), ph.d.(ill.); H. L. Macklin, b.a.sc., o.l.s., d.l.s.; E. I. Robinsky, b.a.(beirut), b.sc.(beirut), m.s.(harvard), ph.d.; J. Schwaighofer, dip.ing(graz.), m.s.(penn. st.), ph.d.(penn. st.), dr.tech. (graz.); R. M. Soberman, b.sc.(dalh.), s.m.(m.i.t.), ph.d.(m.i.t.); C. A. Wrenshall, b.e.(sask.).

Assistant Professors: S. J. G. Bird, m.a.sc.,o.l.s.; R. C. Gunn, m.a.sc.; G. W. Heinke, m.a.sc.; P. H. Jones, b.a.sc., ph.d.(northwest.); I. C. Medland, b.e.(auck.), m.e.(auck.), b.sc.(auck.), ph.d. (manch.); K. Meipoom, m.a.sc.; K. A. Selby, b.a.sc., m.b.a., ph.d.(ill.); J. Timusk, m.a.sc.; S. M. Uzumeri, m.a.sc.; J. Vlcek, b.sc.f.(n.b.), m.a.sc.; G. T. Will, m.a.sc.

Lecturers: V. P. Borecky, dipl.ing.(prague), m.a.; E. Karuks, m.a.sc.; R. G. Tress, b.a.sc.

Special Lecturers: W. E. Carswell, b.arch.; D. M. Hill, m.a.; M. G. Tallon, b.a.sc.; P. Wodzianski, mgr.ph.(warsaw).

DEPARTMENT OF ELECTRICAL ENGINEERING:

Professor and Head of the Department: G. R. Slemon, b.a.sc., m.a.sc., d.i.c.(imp.coll.), ph.d.(lond.).

Associate Professor and Assistant Head of the Department: W. Janischewskyj, b.a.sc., m.a.sc.

Professors: P. P. Biringer, dip.ing.(bud.), m.sc.(stockholm), ph.d.; J. M. Ham, b.a.sc., s.m.(m.i.t.), sc.d.(m.i.t.); N. F. Moody, b.sc.(sask.); G. Sinclair, b.sc.(alta.), m.sc.(alta.), ph.d.(ohio state); V. G. Smith, b.a.sc.; J. L. Yen, b.sc.(chiao tung), m.a.sc., ph.d.

Associate Professors: P. E. Burke, b.e.(n.s.tech.), m.a.sc.; R. C. Cobbold, b.sc.(lond.), m.sc.(sask.), ph.d.(sask.); H. A. Courtice, b.a.sc.; G. W. Dick, b.a.sc., m.a.sc., ph.d.; V. L. Henderson, b.a.sc., a.m.(mich); A. J. Kravetz, b.sc.(alta.), m.a.sc.; G. R. Lang, b.sc.(u.w.o.); I. McCausland, m.sc.(q.u.belfast), ph.d. (tor. and cantab.); H. W. Smith, b.a.sc., sc.d.(m.i.t.); K. C. Smith, b.a.sc., m.a.sc., ph.d.; A. Straughen, b.sc.(lond.), m.a.sc.

Assistant Professors: K. G. Balmain, b.a.sc., m.s.(ill.), ph.d.(ill.); P. I. P. Boulton, b.a.sc., m.a.sc., ph.d.; Miss M. G. Currie, b.a.sc.; I. R. Dalton, b.a.sc., m.s.(northwest); S. Dmitrevsky, m.a.sc., a.m.(harvard), ph.d.(harvard); E. S. Lee, b.eng.(mcg), m.eng.(mcg.), ph.d.; S. D. T. Robertson, b.sc.(queen's), d.i.c. (imp.coll.), m.a.sc., ph.d.; R. S. Segsworth, b.a.sc.

Lecturers: R. T. H. Alden, b.a.sc., m.a.sc.; S. B. Dewan, b.sc.(punjab), m.e.(roorkee), m.a.sc., ph.d.; N. C. McDermott, b.a.sc., m.a.sc.; H. O'Beirne, b.a.(cantab.), m.a.(cantab.), m.a.sc.

Instructors: R. D. Findlay, b.a.sc., m.a.sc.; O. Z. Bluy, b.a.sc., m.a.sc.; C. A. Patel, b.s.e.e.(howard), m.a.sc.

DEPARTMENT OF ENGINEERING SCIENCE:

Head of the Department: B. Etkin, m.a.sc., f.c.a.s.i. (Professor of Aerospace Engineering)

Members of the Department: W. F. Graydon, m.a.sc., ph.d.(minn.) (Professor of Chemical Engineering); T. E. Hull, m.a., ph.d. (Professor of Mathematics); G. D. Scott, m.a., ph.d. (Professor of Physics).

DEPARTMENT OF INDUSTRIAL ENGINEERING:

Professor and Head of the Department: A. Porter, m.sc., ph.d. (manch.).

Professor: B. Bernholtz, m.a., ph.d.(cal.i.t.)

Associate Professors: J. W. Abrams, a.b., ph.d.(calif.); R. W. P. Anderson, m.a.sc.; D. J. Clough, b.a.sc., m.b.a.; P. J. Foley, m.a.(glasgow); S. Kotz, m.sc., ph.d.(cornell).

Visiting Associate Professor: J. G. C. Templeton, a.m., ph.d.(princeton).

Lecturer: H. W. Jackman, m.a.sc.

DEPARTMENT OF MECHANICAL ENGINEERING:

Professor and Head of the Department: G. R. Lord, b.a.sc., s.m.(m.i.t.), ph.d.

Professors: W. D. Baines, b.sc.(alta.), m.s., ph.d.(iowa); F. C. Hooper, b.a.sc., d.i.c.(lond.); L. E. Jones, b.sc.(c.e.)(man.), m.a.sc., ph.d.; I. W. Smith, m.a.sc.

Associate Professors: A. B. Allan, M.A.Sc.; P. B. Hughes, B.Sc.(McG); J. F. Keffer, M.A.Sc., Ph.D.; H. J. Leutheusser, Dip.Ing.(Karlsruhe), M.A.Sc., Ph.D.; F. P. J. Rimrott, Dipl.Ing.(Karlsruhe), M.A.Sc., Ph.D.(Penn.State), Dr.Ing.(Darmstadt); R. T. Waines, B.A.Sc.

Assistant Professors: A. H. Abdelmessih, B.M.E.(Cairo), M.S.(Oklahoma State), Ph.D.; D. L. Allen, B.Sc.(Dal.), B.E.(N.S.Tech.), M.A.Sc., Ph.D.; I. G. Currie, B.Sc.(Strathclyde), M.A.Sc.(B.C.), Ph.D.(Cal.I.T.); G. E. Godfrey, M.A.Sc.; B. H. Karnopp, S.B.(M.I.T.), Sc.M.(Brown), Ph.D.(Wis.); W. J. Moroz, M.A.Sc., Ph.D.(Mich.); D. S. Scott, B.Sc.(Queen's), M.Sc.(Queen's), Ph.D.(Northwestern); B. Tabarrok, B.Sc.(Wolver. & Staff.), D.Phil.(Oxon.); J. Vandevegte, Dipl.Ing(Delft), M.A.Sc., Ph.D.

Special Lecturers: J. P. Bruce, M.A.; F. E. Burke, B.A.(Lond.).

Instructors: R. D. Birse, M.A.Sc.; A. Eidlitz, M.A.Sc.; R. P. Henry, M.A.Sc.; J. G. Lenard, M.A.Sc.; B. D. Pratte, M.A.Sc.; C. B. Rorke, B.Sc.(McG.); R. L. Sakaguchi., M.A.Sc.; J. T. Unsworth, M.A.Sc.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE:

Professor and Head of the Department: L. M. Pidgeon, M.B.E., B.Sc.(Oxon.), Ph.D.(McG.), F.R.S.C.

Professors: K. T. Aust, M.A.Sc., Ph.D.; G. B. Craig, M.A.Sc., Ph.D.; S. N. Flengas, B.Sc.(Athens), D.I.C.(Lond.); H. U. Ross, C.D., M.Sc.(McG.); J. W. Rutter, M.A., Ph.D.

Associate Professors: Mrs. U. Martius Franklin, Ph.D.(Berlin); J. M. Toguri, M.A.Sc., Ph.D.

Assistant Professors: B. Ramaswami, B.Sc., D.I.I.Sc., M.A., Ph.D.(Harvard); W. A. Miller, Ph.D(McG.); R. S. Segsworth, B.A.Sc. (part-time).

DEPARTMENT OF MINING ENGINEERING:

Professor and Head of the Department: H. R. Rice, B.Sc.(Qu.).

Professor: S. E. Wolfe, M.A.Sc., P.Eng.

Instructor: W. J. Riddell, B.Sc.(Qu.).

INSTITUTE FOR AEROSPACE STUDIES:

Professor and Director of the Institute: G. N. Patterson, B.Sc.(Alta.), M.A., Ph.D., LL.D., D.Sc., F.R.Ae.S., F.C.A.S.I., F.A.I.A.A., F.R.S.C., F.A.A.A.S.

Professors: J. H. de Leeuw, Dip.Ing.(Delft), M.S. in A.E.(Georgia Tech.), Ph.D.; B. Etkin, M.A.Sc., F.C.A.S.I.; I. I. Glass, M.A.Sc., Ph.D., F.A.P.S., F.A.A.A.S., F.C.A.S.I.; H. S. Ribner, B.S.(Cal.Tech.), M.S., Ph.D.(Wash.), F.A.S.A., F.C.A.S.I.

Associate Professors: J. B. French, B.A.Sc., M.Sc.(Birmingham), Ph.D.; G. K. Korbacher, Dip.Ing.(Berlin), Ph.D.(Braunschweig).

Assistant Professors: R. C. Tennyson, M.A.Sc., Ph.D.; S. J. Townsend, B.A.(Sask.), M.A.(Sask.), Ph.D.; R. M. Measures, B.Sc., A.R.C.S., D.I.C., Ph.D.(Lond.); P. A. Sullivan, B.E., M.E.(N.S.W.), D.I.C., Ph.D.(Lond.); P. C. Hughes, B.A.Sc., M.A.Sc., Ph.D.

Special Lecturer: R. D. Hiscocks, B.A.Sc., M.B.E., F.C.A.S.I.

SPECIAL LECTURERS:

Special Lecturer in Engineering Law: W. O. C. Miller, B.A.Sc.

PROFESSORS OF OTHER FACULTIES GIVING INSTRUCTION TO STUDENTS IN APPLIED SCIENCE

ACCOUNTING:
Special Lecturer: R. Paretz.

ARCHITECTURE:
Assistant Professor: D. F. D. Pinker, B.Sc.(Lond.), T.P.(Lond.), A.M.T.P.I., A.R.I.C.S., O.L.E.

ASTRONOMY:
Associate Professor: P. R. Demarque, B.Sc., M.A., Ph.D.

BUSINESS ADMINISTRATION:

Professor: T. C. Graham, M.B.E., B.A.Sc.

CHEMISTRY:

Professor: F. E. Beamish, M.A., D.Sc.(McM.).

Associate Professor: M. J. Dignam, B.A., Ph.D.

Assistant Professors: R. G. Barradas, B.Sc.(Liverpool), Ph.D.(Ott.); C. D. Cook, B.Sc.(Manch.), Ph.D.

ECONOMICS:

Assistant Professor: D. M. Nowlan, B.SC., M.A., PH.D.

ENGLISH:

Professor: F. W. Watt, B.A., B.LITT., M.A., PH.D.

GEOLOGY:

Professors: J. B. Currie, B.A.(MCM.), M.A., PH.D.; W. W. Moorhouse, M.A., PH.D.(COL.), F.R.S.C.; E. W. Nuffield, B.A.(B.C.), PH.D., F.R.S.C.; F. G. Smith, M.SC.(MAN.), PH.D.

Associate Professors: G. M. Anderson, B.ENG.(MCG.), M.SC., PH.D.; F. W. Beales, M.A.(CANTAB.), PH.D.; D. H. Gorman, B.SC.(N.B.), PH.D.; W. H. Gross, B.SC.(B.C.), M.A., PH.D.; R. R. H. Lemon, B.SC.(WALES), M.A., PH.D.; P. A. Peach, B.SC.(EDIN.), M.A., PH.D.; W. M. Tovell, M.S.(CAL.TECH.), PH.D.

Assistant Professors: A. J. Naldrett, B.A.(CANTAB.), M.SC., PH.D. (QUEEN'S); G. Norris, M.A., PH.D.(CANTAB.); J. C. Rucklidge, B.A. (CANTAB.), PH.D.(MANCH.).

MATHEMATICS:

Professors: C. Davis, PH.D.; D. B. DeLury, M.A., PH.D.; G. F. D. Duff, M.A., PH.D., F.R.S.C.; W. J. Webber, B.A.(CANTAB.), D.SC.(WATERLOO).

Associate Professors: W. J. R. Crosby, M.A., PH.D.; L. T. Gardner, PH.D.; W. H. Greub, M.A., PH.D.; W. K. Hastings, PH.D.; M. P. Heble, PH.D.; D. K. Sen, M.SC., DR. ÈS SC.; J. R. Vanstone, M.A., PH.D.; R. Wormleighton, B.A., PH.D.(PRINC.).

Assistant Professors: H. A. Akcoglu, M.A., PH.D.; D. R. Breach, PH.D.; R. R. Burnside, A.R.C.S.T., PH.D.; P. B. Chapman, B.SC., B.E., PH.D.; N. A. Derzko, M.A., PH.D.; P. Greiner, M.A., PH.D.; R. L. Johnston, PH.D.; I. MacNeill, PH.D.; D. R. Masson, M.A., PH.D.; R. A. Smith, PH.D.; S. H. Smith, M.A., PH.D.; D. P. Wakfer, M.A.

PHILOSOPHY:

Associate Professor: J. H. Woods, M.A., PH.D.

Assistant Professor: F. F. Wilson, PH.D.

PHYSICS:

Professors: E. J. Allin, m.a., ph.d.; A. W. Brewer, m.sc., ph.d.(lond.); G. D. Garland, m.a., ph.d.(st. louis); R. List, dipl.phys.eth., dr.si.nat.(zurich); J. N. P. Hume, m.a., ph.d.; D. G. Ivey, m.a.(b.c.), ph.d.(notre dame); K. G. McNeill, m.a., d.phil.(oxon); A. D. Misener, m.a., ph.d.(camb.); J. C. Stryland, ph.d.(amst.); L. E. H. Trainor, m.a.(sask.), ph.d.(minn.); J. Van Kranendonk, ph.d.(amst.); H. L. Welsh, m.a., ph.d., d.sc., f.r.s.c., f.r.s.; J. T. Wilson, o.b.e., b.a., m.a.(cantab), ph.d.(princ.), f.r.s.c.

Associate Professors: R. M. Farquhar, m.a., ph.d.; F. S. Grant, b.a.sc., m.a.(ill.), ph.d.; D. A. L. Paul, b.a.(camb.), ph.d.(qu.); R. Richmond, m.a., ph.d.; J. C. Savage, b.s.(ariz.), ph.d.(cal.inst. tech.).

Assistant Professors: R. L. Armstrong, m.a., ph.d.; M. Fowler, b.a., ph.d.(camb.); A. D. May, m.a., ph.d.; J. M. Perz, m.a.sc., ph.d.(camb.); J. D. Poll, ph.d.; R. E. Pugh, m.a.(b.c.), ph.d.(iowa); G. F. West, b.a.sc., m.a., ph.d.; D. York, b.a., d.phil.(oxon.).

POLITICAL SCIENCE:

Lecturer: F. W. Peers.

SECTION IV. HISTORICAL SKETCH

The Legislature Assembly of the Province of Ontario during the Session of 1877 gave its sanction to the establishment of a School of Practical Science on the basis proposed in the memorandum of the Minister of Education confirmed by the Lieutenant-Governor in Council on February 3, 1877.

By the scheme thus approved the Government effected an arrangement with the Council of University College whereby the instruction given by its professors and lecturers in all departments of science embraced in the work of the School was made available to students of the School. This arrangement was brought to an end in 1889 by the transfer of the departments of science, above referred to, from University College to the University of Toronto under the operation of the University Federation Act. In order that the students of the School might continue to enjoy the advantage of the instruction of the above departments, the Senate of the University of Toronto passed a statute in October, 1889, affiliating the School with the University. The statute was confirmed by the Lieutenant-Governor on October 30, 1889.

By an Order-in-Council, approved by the Lieutenant-Governor on the 6th day of November, 1889, a Principal was appointed, and the management of the School was entrusted to a council composed of the Principal as chairman, and the Professors, Lecturers, and Demonstrators appointed in the Teaching Faculty of the School.

On December 14, 1900, the Senate, by statute subsequently approved by the Lieutenant-Governor in Council, established a Faculty of Applied Science and Engineering but without assuming any liability for its support or maintenance. Under this statute the teaching staff and examiners of the School of Practical Science became the teaching staff and examiners of the Faculty, although the University retained the right to appoint the examiners for the Bachelor of Applied Science and professional degrees. By the University Act of 1906 the School of Practical Science became the Faculty of Applied Science and Engineering of the University of Toronto.

On April 8, 1892, the Senate of the University established the Degree of B.A.Sc., which was open to those who held the Diploma of the School and were prepared to devote a fourth year to advanced work. In the Session of 1909–1910 a new course extending over four years and leading to the Degree of B.A.Sc., came into operation, taking the place of the long established diploma course of three years, which came to an end in the Session 1910–1911. In the session 1923–24 the degree was changed to B.Arch. for the students graduating in Architecture. On July 1, 1948, the School of Architecture was separated from the Faculty and became an independent School with its own Director and Council.

With the end of the Second World War during the summer of 1945 the University was faced with the difficult problem of providing

accommodation for almost double the number of students that had been registered in the previous year. Through the efforts of the Chairman of the Board of Governors and the President, the University leased from the Crown part of the large shell-filling plant at Ajax, twenty-five miles east of Toronto, to relieve the heavy demand for space at Queen's Park. Because it became evident, at an early stage, that a relatively large number of students would register in the Faculty of Applied Science and Engineering, it was decided that the work of the First and Second Years of this Faculty should be given at Ajax.

A special First Year session with approximately 1,400 students commenced at Ajax on January 14, 1946. In the regular 1946–47 session both First and Second Year instruction, except Second Year in Architecture, was given at Ajax with 1,800 registered in the First Year and 1,500 in the Second Year. In the 1947–48 session the enrolment at Ajax consisted of 1,200 students in the First Year and 1,400 in the Second Year. In the session 1948–49, 600 were registered at Ajax in the First Year and 975 in the Second Year. All other instruction was given in Toronto.

To provide for this self-contained University community at Ajax, there were 446 acres and 111 buildings. The University operated such services as central heating, road maintenance, water supply, sewage disposal, fire department, transportation, post office, laundry, private hospital, cafeteria, tuck shop and barber shop. Former production-line buildings were altered to accommodate 37 lecture rooms, 20 draughting rooms and 14 laboratories. In the 1946–47 session, 2,300 students were in residence, in 1947–48 there were 1,800 students and in 1948–49 there were 900. Student life at Ajax compared favourably with that in Toronto, excellent accommodation being provided for a general circulating library, a technical library, Hart House Ajax, the Athletic Association, the Health Service, Students' Administrative Council, Advisory Bureau for Ex-Service Students, and a small chapel.

Meanwhile, the erection of the Wallberg Building and an addition to the Mechanical Building was in progress, and with this additional accommodation becoming available on the Queen's Park campus, Ajax was closed on May 31, 1949.

The long-felt need for additional space for Civil Engineering and Electrical Engineering, and the projected expansion of the University as a whole to meet the expected demand for greatly enlarged enrollment, led to the construction of the Galbraith Building. Partially occupied during the 1960–61 session it was officially opened on March 7, 1961, by the Honourable J. Keiller Mackay, D.S.O., V.D., Q.C., LL.D., D.C.L., Lieutenant Governor of Ontario. The building houses Civil Engineering, Electrical Engineering, the Institute for Aerospace Studies, and the Faculty Office.

SECTION V. GENERAL INFORMATION, ADMISSION AND REGISTRATION

Full details of the University of Toronto undergraduate admissions are contained in the undergraduate Admission Circular 1967–68 obtainable on request from the Office of Admissions, University of Toronto, Toronto 5, and available in all Ontario secondary schools. Inquiries about admission to the Faculty of Applied Science and Engineering should be directed to the above-mentioned office.

The right is reserved to limit the number of students admitted to any course in the Faculty.

1. ADMISSION REQUIREMENTS

ONTARIO GRADE 13 REQUIREMENTS: Standing in the following subjects, with an overall average of 70% for Engineering Science, and 64% for all other courses:

Mathematics (A and B); Physics; Chemistry; and an additional subject or subjects comprising 2 credits selected from the Grade 13 subjects approved for purposes of admission to the University.

Note: If a seven-credit programme is presented, at least five of the seven credits must have been obtained in 1967; otherwise the candidate must present nine credits which must include the subjects specified above.

ONTARIO GRADE 12 PRESCRIPTION: Ontario Grade 13 candidates must also have Grade 12 standing in at least six subjects (excluding Physical Education). The subjects chosen must include at least five of the following subjects and at least one subject from each of the four groups:

(i) English
(ii) French; German; Greek; Italian; Latin; Russian; Spanish
(iii) Geography (Parts 1 and 2); History (Parts 1 and 2)
(iv) Mathematics (Parts 1 and 2); Science (Physics and Chemistry)

Note: For admission to the 1967–68 Session and the 1968–69 Session, applications will be considered from candidates who find it impossible to meet the requirements of group (iv) because of the programme taken in Grade 11 in 1964–65 and in 1965–66.

2. APTITUDE AND ACHIEVEMENT TESTS

Ontario students will present the results of all standarized tests offered in the secondary schools. Other students are advised to take the aptitude test of the College Entrance Examination Board, Box 592, Princeton, New Jersey 08540, U.S.A.

3. EQUIVALENT CERTIFICATES

The following certificates are usually accepted as equivalent to Ontario Grade 13 although individual subjects cannot always be equated. Candidates offering Senior Matriculation programmes from provinces other than Ontario must offer at least five subjects and satisfy the subject requirements specified for the course of their choice. Specific details on subjects and standards required for the course must be requested well in advance of the application deadline.

CANADA:

Alberta, Manitoba, Nova Scotia, Saskatchewan—Grade 12.

Newfoundland—First Year Memorial University.

Prince Edward Island—Third Year Certificate of Prince of Wales College.

Quebec—Senior High School Leaving Certificate; McGill Senior School Certificate; English Catholic Senior High School Leaving Certificate (5th Year High—Grade 12). Other certificates will be considered.

ENGLAND, WEST INDIES, EAST AND WEST AFRICA:

(i) General Certificate of Education showing either

(a) Passes in five subjects of which at least two must be passed at advanced level; or

(b) Passes in four subjects of which at least three must be passed at advanced level.

In either case, passes are required in Physics, Chemistry, and an acceptable mathematical subject. At least two of these must be at advanced level.

or (ii) School and Higher School Certificates, which are equated to the General Certificate of Education as follows, and accepted on that basis:

Credits on the School Certificate are accepted as ordinary level passes on the General Certificate of Education; subsidiary passes on the Higher School Certificate as ordinary level passes on the General Certificate of Education; and principal or main subject passes on the Higher School Certificate as advanced level passes on the General Certificate of Education.

HONG KONG:

(i) General Certificate of Education or School and Higher School Certificates as stated above; or

(ii) University of Hong Kong Matriculation Certificate, accepted on the same basis as General Certificate of Education.

(iii) Hong Kong English School Certificate (from 1965 onward) in conjunction with (i) or (ii).

Note: Hong Kong English School Certificates issued prior to 1965 are not acceptable for admission purposes.)

UNITED STATES OF AMERICA:

First Year University credits (a minimum of 30 semester hours) in the required subjects from accredited institutions of higher

learning. A United States High School Graduation Diploma will not normally admit a candidate to any course. Advanced Placement work will, however, be considered.

Candidates seeking admission on the basis of certificates which are in a language other than English must submit photostatic copies of their certificates, rather than the original copies. Notarized English translations of the certificates must accompany the photostatic copies. When the certificates do not indicate the subjects studied and the grades secured in the individual subjects in the final year, candidates are required to submit certified statements from authorized officials of the institutions attended, or submit statutory declarations giving the required information.

4. ENGLISH FACILITY REQUIREMENTS

All applicants are required to submit evidence acceptable to the University of Toronto of facility in English. Candidates whose mother tongue is not English may be required to meet an appropriate standard in a recognized English facility test. The following evidence is acceptable:

(*a*) The University of Michigan English Language Test. This test is available at the University of Toronto for residents of the Toronto area. Enquiries about writing the test in Toronto should be addressed to the Office of Admissions, Simcoe Hall, University of Toronto.

(*b*) The Certificate of Proficiency in English issued by the Universities of Cambridge or Michigan.

Information about writing the tests in (*a*) or (*b*) above in overseas centres may be obtained from the Office of Admissions, Simcoe Hall, University of Toronto.

The University is prepared to consider other evidence of English facility which may be submitted for evaluation to the Office of Admissions.

5. MATURE STUDENTS

Candidates 25 years of age or older who have lived in Ontario for a minimum period of one year may request special consideration if they have not completed the regular admission requirements in full. In order to be admitted to the Faculty of Applied Science and Engineering all such candidates must have Grade 13 or equivalent preparation in mathematics, physics and chemistry. Interested candidates should consult the Office of Admissions for further information.

6. APPLICATION PROCEDURES

All Candidates must submit an application form and supporting documents to the Office of Admissions, University of Toronto, Toronto 5.

Supporting documents include all final secondary school certificates held. These certificates must indicate the subjects studied and grades obtained. If a certificate is not available at the time of application, candidates must indicate the exact name of the certificate to be presented for admission, and the subjects included therein, as well as the approximate date available. A notarized English translation must accompany

certificates which are in a language other than English or French.

In addition a student who has previously attended a University must submit the following:

(i) Official transcripts issued by the University or College previously attended, giving in detail the courses completed, with the standing and grades in each. Transcripts or a supporting letter from the Registrar of the University or College must indicate that the candidate has been granted honourable dismissal and is eligible for re-admission to the institution concerned in the session for which he seeks admission to the University of Toronto;

(ii) Official statements or calendars giving full information on the content of the University courses covered by the transcripts submitted.

For application forms and further information about admission requirements, consult the Office of Admissions, stating in the first letter what credentials will be offered with a listing of subjects and grades obtained.

The closing date for the receipt of applications is June 1. Only in circumstances which the Committee on Admissions deems exceptional will a late application be considered.

7. EARLY ADMISSION
(Ontario Grade 13 students only)

Ontario Grade 13 students wishing to avail themselves of the Early Admission procedures, which will provide by June notification of Early Admission, must forward their applications by March 1. They must also request their Schools to submit the completed Confidential Report Form by that date.

Only a limited number of the available student places in the University are offered under the Early Admission arrangements. All applicants who pass the Ontario Grade 13 examinations with the published admission requirements are eligible for selection to the University.

8. CANDIDATES WHO HAVE PREVIOUSLY FAILED IN UNIVERSITY WORK

Candidates with a pervious failure in university work may be considered individually on their merits; candidates with two previous failures are normally refused admission.

9. PROCEDURE FOR REGISTRATION

Detailed instructions concerning Registration will be mailed to returning and newly admitted students before the beginning of each academic year.

10. HEALTH REQUIREMENTS

Every person admitted to the University as an undergraduate must, at the time of his or her first medical examination by the University

Health Service, present satisfactory evidence of successful vaccination within three years prior to the date of the examination, or must be vaccinated by the examining physician.

11. PROCEDURES FOR WITHDRAWALS OR TRANSFERS

A student who wishes to withdraw or to transfer his course or division in the University should consult his College Registrar or Faculty/School Secretary.

COLLEGES

With the establishment of New College and Innis College, which are open to students of all faculties, it is now possible for students of the Faculty of Applied Science and Engineering to become members of a college. Membership in a college is not obligatory, and application for membership is at the option of the student.

Students entering the First Year who are interested in becoming members of either college should indicate their choice in the space provided on the University's admission application form. A college fee of $15 is required upon acceptance.

The facilities of Innis College and New College are described below.

INNIS COLLEGE

Innis College was constituted on July 1, 1964, and admitted its first students in the following September. It is a multi-faculty college of the University of Toronto, and includes undergraduate students in all Faculties and Schools of the University.

A special feature is the Writing Laboratory. This service offers assistance to Innis College students in the skills and methods of writing essays and other academic reports. A staff of experienced teachers is available to give individual instruction.

NEW COLLEGE

New College is a multi-faculty co-educational college; in addition to students from the Faculty of Arts and Science those from other Faculties and Schools are eligible for membership. This gives students from all divisions of the University the opportunity to participate in the life of a college and to associate with students in other fields of study. Tutorial classes are provided for First Year students in some subjects.

The new building, centrally located on the west campus, provides academic, social and dining facilities for all members of the College and in addition accommodates nearly 300 male students in residence.

Students applying for membership in the College who wish accommodation in the Residence must apply on the prescribed form which may be obtained from the Dean of Students, New College.

RESIDENCE ACCOMMODATION

DEVONSHIRE HOUSE

Devonshire House, the University Residence for Men, accepts students from all Faculties. The facilities of the residence include a library, music listening room, music practice room, common rooms, kitchenettes, laundry room, television and games rooms. It does not have a dining hall. Members may take their meals at Hart House, Howard Ferguson Hall, or New College, all located nearby.

Application forms may be obtained from the Secretary to the Dean, Devonshire House, University of Toronto. Application should be made as early as possible.

NEW COLLEGE

The residence facilities of New College, and the procedure for application, are described in the entry under Colleges, above.

Each of the four Arts Colleges also maintains a Men's Residence, into which some engineering students may be accepted. Further information may be obtained from

University College—Dean of Men
Victoria College—Senior Tutor
Trinity College—Registrar, Trinity College
St. Michael's College—Dean of Men

HOUSING SERVICE

For the convenience of those students who are not able to find accommodation in the University and College residences, the University maintains a listing of rooming houses, flats, apartments and homes. Information on these rooms may be obtained through the Housing Service office at 134 St. George Street, Toronto 5.

Off-campus housing of this nature is not subject to University regulation. However every effort is taken to make the information on the accommodation as complete as possible and students are encouraged to assist in this effort by reporting on the quality of the accommodation that they have occupied.

CAMPUS CO-OPERATIVE RESIDENCE

The Campus Co-operative Residence, Inc. offers certain housing accommodations for undergraduate and graduate students. Since the University of Toronto has no official connection with the Campus Co-operative Residence, Inc., inquiries about accommodation available through that organization should be addressed directly to:

Campus Co-operative Residence, Inc.,
395 Huron Street,
Toronto 5, Ontario.

SECTION VI. FEES, DEPOSITS AND EXPENSES

FEES

1. A student who desires to enrol in the Faculty of Applied Science and Engineering is required to pay at least the First Term Instalment of fees on or before the opening date of the session, and before he can receive his admit-to-lectures card from the Secretary of the Faculty. The amount of the First Term Instalment of fees or of the Total Fee for the session may be ascertained from the schedule of fees below.

2. The Second Term Instalment of fees, if not already paid, is due on the opening day of the second term and must be paid not later than January 15. After this date an additional fee of $3 per month or portion thereof (not exceeding $10), will be imposed until the whole amount is paid. All fees for the session must have been paid in full before the student can be admitted to the annual examinations.

3. Students will receive by mail in August a fees form and instructions for the payment of fees. In order to avoid delay in registration at the opening of the session it is recommended that at least the first term instalment of fees be forwarded by mail as early as possible in September.

4. Each undergraduate enrolled in the Faculty of Applied Science and Engineering must pay annual fees to the Chief Accountant according to the schedule below; the total fee in each case is made up of the academic fee and incidental fees; all incidental fees are payable in the first term.

Schedule of Fees

Men

Academic Year	*Academic Fee	†Incidental Fees	Total Fee (if paid in one instalment)	First Term Instalment	Second Term Instalment
I-IV	$650	$63	$713	$388	$328

Women

I-IV	$650	$35	$685	$360	$328

*The Academic Fee includes the following fees:
Tuition; Library and Laboratory Supply; one Annual Examination; Laboratory Fee; and Degree.

†These Incidental Fees include the following fees:
For men—Hart House; Students' Administrative Council; Athletic; Health Service; Engineering Society; Faculty Athletic Association.
For women—Students' Administrative Council; Athletic; Health Service; Engineering Society.

LATE REGISTRATION FEE

6. Any student who registers after the last date for normal registration in his or her own faculty or school is required to pay a late registration fee of $10 plus $1 for each day of delay to a maximum of $20.

OTHER UNIVERSITY FEES

7. Each student is required to pay to the Chief Accountant at the opening of the session, or as otherwise specified, such of the following fees as may be required of him.

EQUIVALENT CERTIFICATE FEE

8. Each student who has been admitted to the First Year upon a certificate or certificates granted outside the Province of Ontario and covering all or any part of the admission requirements, must pay a fee of $5.

ADVANCED STANDING FEE

9. Each student who has been admitted to advanced standing from another university or college, must pay a fee of $10.

SPECIAL STUDENTS FEES

10. The fee is $95 per subject, payable to the Chief Accountant.

SUMMARY OF STUDENTS' EXPENSES

11. The following approximate statement of expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering in the University of Toronto, exclusive of personal expenses:

1. Fees, see schedule page 23.
2. Board and Lodging, per week .....$20 up
3. Books and instruments, per year .....about $125

CHILDREN OF WAR DEAD (EDUCATION ASSISTANCE) ACT

Children of War Dead (Education Assistance) Act provides fees and monthly allowances for children of veterans whose death was attributable to military service. Enquiries should be directed to the nearest District Office of the Department of Veterans Affairs.

SECTION VII. COURSES AND DEGREES

THE UNDERGRADUATE PROGRAMME

The Faculty offers the following courses leading to the degree of Bachelor of Applied Science:

Civil Engineering (Course 1)
Mechanical Engineering (Course 3)
Industrial Engineering (Course 4)
Engineering Science (Course 5)
Chemical Engineering (Course 6)
Electrical Engineering (Course 7)
Metallurgy and Materials Science (Course 8)
Geological Engineering (Course 9)
Aerospace Engineering (offered as an option in Engineering Science. See page 60).

The courses extend over four academic sessions. Full time attendance during the academic session is required; the Faculty does not offer part-time or evening courses leading to the degree.

The curricula of the various courses are set out in detail in Section VIII.

The requirements respecting examinations and promotion and the general regulations concerning students in attendance are shown in Section IX.

GRADUATE STUDY AND RESEARCH

Facilities are available in the Departments of the Faculty for post-graduate study and research leading to the degrees of Master of Engineering (M.Eng.), Master of Applied Science (M.A.Sc.), and Doctor of Philosophy (Ph.D.). For further information see the Calendar of the School of Graduate Studies.

DIPLOMA COURSE IN OPERATIONS RESEARCH

A one-year diploma course in Operations Research is offered for those who have obtained a bachelor's degree in engineering, science, or mathematics. The diploma course is designed specifically to meet the needs of people who are presently employed in industry and who aspire to develop special skills in the design, analysis, and control of complex organizational systems. The course may not be offered in a particular session if conditions prevailing render it impracticable to do so.

Inquiries regarding the Diploma Course in Operations Research should be directed to the Secretary, Faculty of Applied Science and Engineering.

SPECIAL STUDENTS

Graduates of the University of Toronto and of recognized universities who wish to take one or more undergraduate subjects may be registered

as special students in the Faculty of Applied Science and Engineering, subject to the approval of the teaching department concerned. Application must be made to the Secretary of the Faculty.

INTERIM HIGH SCHOOL ASSISTANT'S CERTIFICATE TYPE A

Graduates of engineering courses may be admitted to Type A certificate courses at the College of Education, University of Toronto, if they submit official transcripts which indicate that they have sufficient academic credits.

Graduates of engineering courses who lack sufficient academic credits for admission to Type A courses at the College of Education may be eligible for admission to the Type B course and later for endorsement of the Type B certificate.

Inquiries regarding admission to the Type B course should be addressed to the Registrar, the College of Education, University of Toronto. Inquiries regarding endorsement of Type B certificates or admission to Type A certificate courses should be addressed to the Director, Committee on Advanced Standing, the College of Education, University of Toronto.

ASSOCIATIONS OF PROFESSIONAL ENGINEERS

Graduation from the Faculty of Applied Science and Engineering leads to registration as a Professional Engineer in the various Associations of Professional Engineers throughout Canada.

SECTION VIII. CURRICULUM

The courses are designed to give the student a thorough grounding in the fundamentals of engineering, with emphasis on their practical application in the field in which he has chosen to study. In the First Year there is no differentiation between the various courses with the exception of Engineering Science. In the succeeding years, specialization develops to a considerable extent, with provision in the Third and Fourth Years for optional subjects in some of the courses.

The Faculty has excellent laboratory facilities, in which the students do practical experiments and problems related to the lecture subjects. In some graduating courses, laboratory work in the Fourth Year consists of the investigation of some specific problem. In all instances, the student's knowledge of the original literature and primary sources of information is extended, and he is given a very desirable and useful training in methods of research. As part of the laboratory instruction, excursions to places of technical interest are arranged by the staff. These excursions are treated as laboratory periods, with the same requirements as to attendance and reports.

As in the case with other professions, the engineer should be prepared to assume positions of professional and community leadership. Accordingly, the curriculum contains a basic core of humanistic-social studies, including English, Political Science, Economics, Modern History, and Philosophy of Science. It is hoped that this introduction to the humanities will stimulate the student to do further reading and study, thereby increasing his professional effectiveness.

On the following pages of this section, the curriculum for each course is set forth in detail. The time devoted to lectures and practical work is indicated as accurately as possible, but is subject to modification as occasion may require. The programme and regulations regarding the courses of study and examination, contained in this Calendar, hold good for this academic year only, and the Faculty of Applied Science and Engineering does not bind itself to adhere for the whole period of a student's course to the conditions here laid down.

Communications relating to curricula, instruction, and examinations in the Faculty of Applied Science and Engineering should be sent to the Secretary of the Faculty.

For information regarding the courses of study leading to the post-graduate degrees, Master of Engineering, Master of Applied Science, and Doctor of Philosophy, see the calendar of the School of Graduate Studies, which gives full particulars.

FIRST YEAR CURRICULUM

The courses in Civil Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering, Metallurgy and Materials Science, and Geological Engineering are designated as Division A and have a common First Year. The First Year curriculum in Engineering Science is designated as Division B.

A student who has successfully completed the First Year in Division A may transfer to any other course within that Division at the beginning of the Second Year; a student who has successfully completed the First Year in Division B will likewise be permitted to transfer to any course in Division A.

Students wishing to transfer should make application to the Secretary of the Faculty not later than August 15.

FIRST YEAR CURRICULUM

Division A

Civil Engineering
Mechanical Engineering
Industrial Engineering
Chemical Engineering
Electrical Engineering
Metallurgy and Materials Science
Geological Engineering

First Year Subjects Division A	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	600, 601	2	3	2	3
Engineering Graphics	135	1	3	1	3
English	2110	2	—	2	—
Mathematics:					
Algebra and Analytic Geometry	2410	2	1	2	1
Calculus	2411	2	1	2	1
Engineering Applications of Mathematics	13	—	2	—	1
Physics:					
Electricity	700	2	¾	2	¾
Mechanics	100	2	¾	2	¾
Structure and Properties of Matter	2501	2	1½	2	1½
Computer Programming	12	—	—	1	1
Engineering Seminars	11	—	½	—	½

DIVISION B
Engineering Science

FIRST YEAR SUBJECTS DIVISION B	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	602, 601	2	3	2	3
Computer Programming	12	—	—	1	1
Engineering Graphics	135	1	3	1	3
English	2110	2	–	2	–
Mathematics:					
Algebra and Geometry	2415	2	3	2	3
Calculus	2416	2		2	
Physics:					
Electricity	701	2	–	2	–
Statics	101	2	–	–	–
Properties of Matter; Mechanics and Heat	2511, 2512	3	4	3	4
Engineering Seminars	11	—	½	–	½

CIVIL ENGINEERING

(Course 1)

The course in Civil Engineering has been so designed as to be broad and comprehensive. It has been designed not only to meet the needs of those who have definitely decided to enter this branch of the profession, but also of those who desire an engineering education of such a basic character as to enable them to enter various other fields of engineering employment.

In addition to instruction in engineering subjects, sufficient time is assigned to economic, legal and administrative studies to qualify the graduate in this course not only to engage in any of the branches of Civil Engineering but also to do administrative or executive work in industrial, commercial, government or other undertakings of an engineering character.

In the final year three options are offered:

A—Structural

B—Surveying

C—Geotechnical, Municipal and Transportation

Because of the common core of Civil Engineering material in the course, a graduate in any option will not be at a serious disadvantage when engaged in engineering work that is more closely associated with one of the other options.

Most of the subjects in the Third Year are taken by all students, but, in addition to these common subjects, students proceeding to options A and C in the Fourth Year must take the Group A subjects while those proceeding to option B must take the Group B subjects.

The subjects of instruction are shown in the following tables. In these tables numbers have been assigned to the subjects which refer to a more detailed description of each, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Calculus	2420	2	1	2	1
Computer Programming	145	2	2	—	—
Dynamics	350	1½	—	—	—
Economics	2720	2	—	2	—
Electrical Engineering	724	—	—	2	—
Engineering Chemistry	607	2	—	—	—
Engineering Graphics	138	—	4½	—	4
Engineering Optics and Astronomy	152	1	—	1	1½
Engineering Thermodynamics	302	—	—	1½	—
Geology for Engineers	2900	2	—	1	3
Mechanics of Materials	105, 104	2	—	2	3
Physical Metallurgy	815	—	—	2	—
Practical Experience	20	—	—	—	—
Surveying	153	2	4	1	3

Each student in Civil Engineering is required to state, not later than June 30 following the completion of his Second Year, the group of subjects he desires to pursue in the Third Year. Permission to take either group of subjects must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

THIRD YEAR SUBJECTS COURSE 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Fluid Mechanics	333	2	–	2	3
Highway Engineering I	185, 195	2	1½	–	–
Engineering Mathematics	141, 139	2	1½	2	3
Municipal Planning, Administration and Transportation	186	–	–	3	–
Practical Experience	20	–	–	–	–
Sanitary Engineering	180	2	–	–	–
Soil Mechanics	191, 195	2	1½	–	–
Survey Camp	158	–	–	–	–
One of					
History	2330 or 2332	2	–	2	–
Political Science	2730				
And either of the following groups of subjects:					
GROUP A (Leading to options 1A and 1C)					
Mechanics of Materials II	110, 113	2	7½	2	6
Structural Design I	111, 113	2		2	
Structural Theory I	112, 113	–		3	
GROUP B (Leading to option 1B)					
Geodetic Engineering	160, 161	–	–	2	3
Least Squares	159	–	3	–	–
Photogrammetry I	162, 163	2	3	–	–
Photo Interpretation	164, 165	–	–	2	3
Structural Design I	111, 115	2	1½	2	3

Civil Engineering students selecting the Group A subjects are required to state not later than June 30 following the completion of their Third Year the options (one of options 1A or 1C) they desire to pursue in the Fourth Year. Permission to enter upon an option must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Civil Engineering students selecting the Group B subjects in their Third Year must pursue option 1B in their Fourth Year.

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Construction Management.....	130	–	–	2	–
Engineering Law.....	3440	1	–	–	–
English.....	2140	1	–	1	–
Hydraulic Engineering.....	343	2	3	–	–
Philosophy of Science.....	2040	2	–	–	–
And one of the following options:					
OPTION 1A (Structural)					
Behaviour and Design of Steel Structures.....	118	2	2	2	2
Mathematical Applications....	140	–	–	2	1½
Reinforced Concrete I.....	116	2	1½	2	1
Reinforced Concrete II.....	117	2	1	2	1
Soil Mechanics and Foundations	192	2	–	1	2
Structural Theory II.....	119	2	2	3	2
Thesis Project and Mechanics of Materials Laboratory.....	40, 120	–	4	–	4
OPTION 1B (Surveying)					
Astronomy.....	172	–	–	1	3
Engineering and Legal Surveys	174	1	–	2	–
Geodesy and Electronic Surveying.....	175	2	1½	2	3
Geodetic Adjustments.....	168	1	3	1	3
Photogrammetry II.....	170	1	3	1	1½
Structural Engineering II.....	122	2	4½	2	3
Survey Camp.....	167	–	–	–	–
Town and Regional Planning ..	3540	1	3	1	3
Thesis.....	40	–	–	–	1

Fourth Year Subjects Course 1	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 1c (Geotechnical, Municipal and Transportation)					
Mathematical Applications	140	–	–	2	1½
Reinforced Concrete I	116	2	3	2	3
Soil Mechanics and Foundations	192	2	–	1	2
Thesis	40	–	2	–	4½
Elective		3	2	–	–
Elective		3	2	–	–
Elective		–	–	3	2
Elective		–	–	3	2

First Term Electives* (choose 2)

Air Photo Interpretation	189
Engineering Geology	194
Environmental Planning	184
Pollution Control Sciences	181
Traffic Engineering	187

Second Term Electives* (choose 2)

Foundations and Earthworks	193
Municipal Engineering	182
Pollution Control Engineeering	183
Transportation Engineering	188

*In special cases, depending upon student interest and staff availability, one or more electives *may* be offered both terms, or not at all.

MECHANICAL ENGINEERING

(Course 3)

Traditionally associated with the art and science of power generation and the machines and devices by which power is usefully applied and controlled, Mechanical Engineering, like other branches of the engineering profession, participates actively in the advancement of knowledge and interprets this knowledge in the design and development of practical systems.

In manufacturing industry, in the transportation and power utilities, in the high-performance field of air and space engineering, or in engineering aspects of major works and structures, the mechanical engineer finds professional occupation, either as employee or consultant. His responsibility will generally be for the superintendence of operations and personnel, for the design of products and processes, and may include the administration of enterprises.

The curriculum in Mechanical Engineering provides an analytical training in mathematics and the physical sciences designed as a disciplinary basis for active professional practice. Recognition is given, however, to the purer scientific and philosophical concepts essential to postgraduate study and research.

The subjects of instruction are shown in the following tables, in which the assigned Subject Numbers refer to the more detailed descriptions given later, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Calculus	2420	2	1	2	1
Design of Machine Elements	356, 357	–	–	2	3
Dynamics	351	3	–	–	–
Economics	2720	2	–	2	–
Electrical Engineering I	722, 723	2	3	2	1½
Materials Science	834	2	–	2	1½
Mechanics of Materials	107, 104	3	–	1	3
Numerical Methods	384	2	3	–	–
Probability and Statistics	2422	–	–	2	–
Theory of Machines	358	–	–	2	3
Practical Experience	20	–	–	–	–

Third Year Subjects Course 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Equations	2432	2	–	2	–
Electronics	743, 744	2	1½	–	–
Electric Machines	747, 748	2	1½	2	3
Engineering Analysis	386	–	1½	–	3
Engineering Thermodynamics	309, 310	2	3	2	3
Fluid Mechanics	334	2	–	2	3
Heat Engineering	308	2	–	1	–
Machine Design	363, 364	2	6	–	3
Practical Experience	20	–	–	–	–
Treatment of Technical Data	387	–	–	2	3
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 3	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Engineering	390	1	3	2	3
Elementary Control Theory	391, 392	1	–	1	3
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Heat Engineering Laboratory	324	–	3	–	4½
Hydraulics	344, 345	2	3	2	4½
Industrial Management	396	1	–	–	–
Machine Design	373, 374	2	3	2	4½
Philosophy of Science	2040	2	–	–	–
Practical Experience	20	–	–	–	–
Structural Engineering	126, 127	2	3	–	–
Thermal Energy Conversion I	322	2	–	2	–
Thermal Energy Conversion II	323	–	–	2	–
Thesis	40	–	1	–	1

INDUSTRIAL ENGINEERING

(Course 4)

The modern view of Industrial Engineering is that of a field concerned with the analysis, design, improvement and operation of integrated systems of men, materials and equipment. This concept crystallized when it became clear that certain modern technical fields, including operations research, control theory, computer science, probability and statistics, systems theory and human factors engineering, constituted a body of knowledge particularly useful in the operation and management of modern business, industry and government.

As a logical outcome of this development, the course in Industrial Engineering was established in 1958 to provide graduates in engineering specializing in the theory and practice of these subjects. This specialization rests upon a substantial foundation in science and mathematics, in fundamental engineering disciplines including fluid mechanics, applied thermodynamics, electric science, mechanics of materials, materials science and automation, and in such subjects as economics, organizational structure, financial control and industrial psychology.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28

Second Year Subjects Course 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Calculus	2420	2	—	2	—
Computer Programming I	3333	1	1½	1	1½
Economics	2720	2	—	2	—
Electrical Engineering	719, 720	2	3	2	3
Elements of Industrial Engineering	414	2	—	2	—
Materials Science	834	2	—	2	3
Mechanics of Materials	102, 104	2	3	2	—
Probability and Statistics I	2423, 2424	2	2	2	2
Practical Experience	20	—	—	—	—

THIRD YEAR SUBJECTS COURSE 4	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Accounting	2734	2	—	2	—
Computer Programming II	3335	1	1½	1	1½
Differential Equations	2432	2	1½	2	1½
Control Engineering	394, 395	2	3	2	3
Engineering Thermodynamics	311, 312	—	—	2	3
Fluid Mechanics	337	2	3	—	—
Numerical Analysis	2433, 2434	2	1½	2	1½
Probability and Statistics II	2430, 2431	1	1½	1	1½
Practical Experience	20	—	—	—	—
and one of					
History	2330 or 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR SUBJECTS COURSE 4 (*1967–68 only*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Human Factors Engineering	410	–	–	2	–
Dynamics of Industrial Systems	405	2	3	–	–
Elementary Control Theory	407, 408	2	3	2	3
Electric Machines	760, 761	2	3	–	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Industrial Engineering Seminar	411	–	2	–	2
Industrial Psychology	2840	–	–	2	–
Machine Design	375, 376	2	3	2	3
Operations Research I	401, 402	2	3	2	3
Operations Research II	403, 404	–	–	2	3
Philosophy of Science	2040	2	–	–	–
Practical Experience	20	–	–	–	–
Thesis	40	–	2	–	2

Fourth Year Subjects Course 4 (*1968–69 and subsequently*)	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Automatic Control of Processes	415	2	—	2	—
Engineering Law	3440	1	—	—	—
English	2140	1	—	1	—
Human Factors Engineering	416	3	—	3	—
Industrial Engineering Seminar	417	—	2	—	2
Management Science	418	2	—	2	—
Operations Research	419	2	3	4	3
Philosophy of Science	2040	2	—	—	—
Systems Theories	420	2	3	2	3
Thesis Project	40, 421	—	6	—	6

ENGINEERING SCIENCE

(Course 5)

The Engineering Science Course is designed for those who plan ultimately to enter the fields of research and development or teaching and who have ability in mathematics and science above the average. Most graduates from this course proceed to graduate study.

The first two years are common but in the third and fourth years there are eight options to meet the special interests of the students. The options prepare the student for graduate work in most of the Engineering Departments, in Physics, in Applied Mathematics, in the Institute for Aerospace Studies, in the Institute of Computer Science and the Institute of Biomedical Electronics.

The admission requirements for this course are set forth in detail on page 17 of this Calendar. An average of 70% on the specified papers of Grade XIII is required.

Only students who obtain a weighted average of 66% or higher in the examinations of the First Year may proceed to the second year in the Engineering Science Course but those who obtain 60% or higher may proceed to the second year of any one of the other courses in the Faculty. The First Year of the Engineering Science Course may not be repeated without the special permission of the Council of the Faculty.

The subjects of instruction are shown in the following tables and are more fully described according to subject reference number, pages 61 to 120.

For FIRST YEAR CURRICULUM—DIVISION B, see page 29.

Second Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Differential Calculus	2425	2	–	2	–
Economics	2720	2	–	2	–
Electric Circuits	715, 716	2	1½	2	1½
Integral Calculus	2426	2	–	2	–
Mathematical Problems and Machine Computation	2428	–	3	–	3
Mechanics of Materials	103	1	–	1	–
Numerical Methods	2429	1	–	1	–
Physical Chemistry	608, 609	2	1½	2	1½
Physics	2521, 2522	3	3	3	3
Probability and Statistics	2427	2	–	2	–

Students are required to state before the end of their Second Year which option they intend to pursue. Council retains the right to withhold an option if the number of students offering or conditions existing at the time render it impracticable to give the work.

Third Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Mechanics of Structures	1034, 1035	2	1½	2	3
Fluid Mechanics	1028, 1029	2	3	1	1½
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

THIRD YEAR SUBJECTS COURSE 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5c, Chemical					
Atomic and Molecular Structure	2631	2	–	2	–
Chem. Eng. Rate Processes	641	2	–	2	–
Chem. Eng. Thermodynamics	640	2	–	2	–
Chem. Eng. Problems and Lab.	642	–	9	–	7½
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Fluid Mechanics	338	2	3	2	3
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2703				
Option 5cs, Computer Science					
Advanced Programming I	788	3	6	–	–
Advanced Programming II	789	–	–	3	6
Atomic Structure and Quantum Physics	2533	2	–	2	–
Circuit Analysis	742	2	–	2	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				
Option 5e, Electrical					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Circuit Analysis	742	2	–	2	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Physics of Metals	819	–	–	2	–
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Third Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5g, Geophysics					
Advanced Mechanics	1030	2	–	2	–
Astronomy and Geophysics	2537	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Differential Equations	2438	2	–	2	–
Electronics	740, 741	2	–	2	1½
Physics Laboratory	2532	–	6	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				
Option 5m, Materials Science					
Advanced Mechanics	1030	2	–	2	–
Atomic and Molecular Structure	2631	2	–	2	–
Chemistry of Metals	802, 829	2	–	–	3
Differential Equations	2438	2	–	2	–
Metallurgical Thermodynamics	830, 831	1	2	1	2
Materials Science	832	2	–	2	–
Physics of Metals	821, 822	2	6	2	3
Physics of Solids and Fluids	2534	1	–	1	–
Theory of Functions	2437	2	–	2	–
X-ray Crystallography	2901	–	2	–	2
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				
Option 5nt, Nuclear and Thermal Power					
Advanced Mechanics	1030	2	–	2	–
Applied Elasticity	365, 366	1	3	1	3
Atomic and Nuclear Physics	2535	2	–	2	–
Differential Equations	2438	2	–	2	–
Fluid Mechanics	338	2	3	2	3
Heat Engineering	313, 314	1	3	1	3
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–

THIRD YEAR SUBJECTS COURSE 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				
Option 5p, Physics					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	2	–	2	–
Crystallography	2902	1	–	1	–
Differential Equations	2438	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531	–	–	2	–
Theory of Functions	2437	2	–	2	–
One of:					
Applied Elasticity	365, 366	1	3	1	3
Circuit Analysis	742	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 5	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Option 5a, Aerospace					
Aerodynamics	1040, 1041	2	1½	2	1½
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electronic Circuits	778, 769	3	3	–	–
Engineering Design	1043	–	3	–	6
English	2140	1	–	1	–
Gasdynamics	1048, 1049	1	1½	2	3
Philosophy of Science	2040	2	–	–	–
Plasmadynamics	1046	2	–	2	–
Thesis	40	–	–	–	–
Transport Phenomena	1050	–	–	2	–
and either (A) or (B) below:					
(A) Physics and Mechanics of Solids	1044, 1045	2	3	2	3
(B) Electromagnetic Radiation and Matter	2541	2	–	2	–
Plasma Diagnostics	1047	–	3	–	3
Option 5c, Chemical					
Chem. Eng. Design	666	2	6	2	6
Chem. Eng. Laboratory	652	–	9	–	–
Thermodynamics of Chemical Systems	665	3	–	–	–
Dynamics of Chemical Systems	667	–	–	3	–
English	2140	1	–	1	–
Instrumental Methods	663	–	–	2	–
Mass Transfer	650	2	–	2	–
Organic Chemistry	660, 661	2	–	1	6
Philosophy of Science	2040	2	–	–	–
Physics of Metals	816	1	–	1	–
Process Dynamics	664	2	–	2	3
Thesis	40	–	–	–	–
Option 5cs, Computer Science (commencing in 1968–69)					
Computer Logic and Design	781	2	–	1	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electronic Circuits	778, 769	3	3	–	–
English	2140	1	–	1	–
Information Systems I	782	2	–	1	
Information Systems II	786, 783	–	–	2	3

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Mathematical Foundations of Computer Science	2439	2	–	2	–
Numerical Solution of Partial Differential Equations	2440	–	–	3	3
Philosophy of Science	2040	2	–	–	3
Techniques of Optimization	787	2	3	2	3
Thesis	40	–	–	–	–
Option 5e, Electrical					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Energy Conversion Processes	745, 746	2	1½	2	1½
Electronic Circuits	778, 769	3	3	–	–
English	2140	1	–	1	–
Information Systems I	782	2	–	1	–
Information Systems II	786, 783	–	–	2	3
Philosophy of Science	2040	2	–	–	–
Quantum Mechanics	2545	2	–	2	–
System Dynamics	766, 767	2	1½	2	1½
Wave Theory	790, 791	2	–	3	3
Thesis	40	–	–	–	–
Option 5g, Geophysics					
Atmospheric Physics	2571	2	–	2	–
Control Systems	398, 399	1	–	2	3
Differential Equations of Mathematical Physics	2445	2	–	2	–
English	2140	1	–	1	–
Geophysics Laboratory	2573	–	6	–	9
Geophysical Methods	2561	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics of the Earth	2570	2	–	2	–
Principles of Geology	2920	2	2	2	2
Solids within the Earth	2572	2	–	2	–
Thesis	40	–	–	–	–
Option 5m, Materials Science					
Chemistry of Metals	805	2	–	2	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
English	2140	1	–	1	–
Philosophy of Science	2040	2	–	–	–
Materials Science Laboratory	827	–	12	–	12
Materials Science Seminar	826	–	3	–	3

Fourth Year Subjects Course 5—*Continued*	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Physics of Metals	823, 824	4	3	4	3
Thesis	40	–	–	–	–
And one of:					
Physical Electronics	738, 739	2	–	2	3
Materials Science Laboratory	827	–	3	–	3
Option 5nt, Nuclear and Thermal Power					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Control Systems	398, 399	1	–	2	3
English	2140	1	–	1	–
Heat Transfer	328	–	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Nuclear Engineering	670, 671	2	3	2	3
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	3	–	3
Thermal Energy Conversion	331, 332	3	3	3	3
Computational Methods	393	1	3	1	3
Thesis	40	–	–	–	–
Option 5p, Physics					
Electronic Circuits	778, 769	3	3	–	–
Differential Equations of Mathematical Physics	2445	2	–	2	–
Electromagnetic Radiation and Matter	2541	2	–	2	–
English	2140	1	–	1	–
Molecular Physics and Statistical Mechanics	2543	2	–	2	–
Nuclear and High Energy Physics	2544	2	–	2	–
Philosophy of Science	2040	2	–	–	–
Physics Laboratory	2542	–	6	–	6
Quantum Mechanics	2545	2	–	2	–
Wave Theory	790	2	–	3	–
Thesis	40	–	–	–	–

CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

(Course 6)

The chemical engineer is concerned with the development and operation of processes by means of which matter is chemically altered to a more useful form, and in the design, construction, operation and management of plant in which to effect such changes. Apart from such obviously chemical processes as those concerned with the production of acids, alkalis, salts, petroleum, rubber products, pulp and paper, explosives, paints and varnishes, soap, plastics, etc., there are many industrial processes where chemistry plays a part, or where a knowledge of chemistry is valuable. There is thus a wide field of endeavour for the chemical engineer. In order to equip a student to enter this field, the course in chemical engineering is intended to provide the student with training in the principles of the major divisions of chemistry and chemical engineering, together with an understanding of other engineering subjects.

As part of the work of the Fourth Year each student is assigned a problem involving original investigation, in order to let him apply to some extent what he has learned, and to introduce him to the chemical literature. It also serves as an introduction to research for those who are attracted to it, and who, because of their basic training are equipped to carry on research in chemistry or chemical engineering at the graduate level or in laboratories outside the university. The nature of this thesis problem may vary widely depending on the interests of the staff and students. It may, for example, be concerned with an experimental laboratory investigation, the design of a process, or a computer study of a chemical system.

For those students considering taking up the teaching of science in high schools as a profession, the nature and extent of the thesis subject in the Fourth Year may be modified to allow the student to take such other instruction as may be necessary to shorten the time required before becoming professionally qualified.

The subjects of instruction are shown in the following tables. In these tables reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	615, 614	2	9	–	–
Analytical Chemistry and Computation Laboratory	613	–	–	–	–
Calculus	2420	2	1	2	1
Chemical Engineering Science Laboratory	619	–	–	–	7½
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Introduction to Mass and Heat Transfer	631	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	102	2	–	2	–
Physical Chemistry	2622	2	–	2	–
Process Calculations	620	–	3	–	3
Practical Experience	20	–	–	–	–

Third Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	633	1	1	1	1
Chemical Engineering Thermodynamics	640	2	2	2	2
Chemical Laboratory	627	–	6	–	6
Reaction Kinetics	625	1	–	1	–
Fluid Mechanics	339, 632	2	3	2	–
Industrial Chemistry	630	2	–	1	–
Mass Transfer Operations	650	2	1	2	1
Organic Chemistry	628, 629	2	6	2	9
Practical Experience	20	–	–	–	1
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 6	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics in Chemical Engineering	653	–	–	–	3
Chemical Engineering Thermodynamics and Kinetics	655	2	–	2	–
Chemical Engineering Laboratory	652	–	9	–	–
Chemical Plant Design	651	2	6	–	–
English	2140	1	–	1	–
Mass Transfer Operations	650	2	–	2	–
Organic Chemistry	654	–	–	2	–
Philosophy of Science	2040	2	–	–	–
Practical Experience	20	–	–	–	–
Public Speaking	656	–	1	–	1
Thesis	40	–	1	–	18

ELECTRICAL ENGINEERING

(Course 7)

Electrical Engineering is concerned with the science and art of controlling one of the fundamental particles of nature, the electron. Man's ability to control the electron has played a singular role in producing and sustaining the present explosive development in technology.

Electrical engineers contribute to the development of this technology in the following ways:

(1) By providing measuring devices capable of acquiring precise data on the behaviour of processes and systems.

(2) By providing electrical communication systems capable of transmitting data and intelligence rapidly and reliably over distances ranging in scale from microminiature to interplanetary.

(3) By providing electronic computer systems, both digital and analogue, capable of rapidly processing large volumes of data, and of solving complex problems.

(4) By providing means of generating and making universally available ever-increasing amounts of electrical power and by providing an extremely wide range of devices for converting this versatile form of energy into other forms required to energize and control processes and systems.

(5) By coordinating the application of these technologies to make possible the control and automation of complex systems.

(6) By helping to provide sophisticated research tools for the scientist—for example, computers, particle accelerators, radio telescopes, biomedical probes.

Within any of these areas the electrical engineer may be engaged in research, development, design, manufacture, operation or management. Since few systems are purely electrical, he must work closely with engineers of other disciplines as well as with scientists, businessmen, technologists and many others.

The electrical engineer must make extensive use of mathematical models in treating the phenomena which he encounters, and hence a natural aptitude for mathematics is a basic requirement. Indeed, the best single index of potential ability in engineering is a facility with mathematics.

Stress is laid in the curriculum on building a solid foundation which will allow the student to choose a career in any area of practice. Although a small amount of specialization is provided in the fourth year, it is intended that the real specialization will take place in industrial practice or in post-graduate work.

Electrical engineering is characterized by the relatively large proportion of its graduates who proceed to post-graduate degrees. Fields of advanced study in electrical engineering in the Faculty include computer systems, control systems, electromagnetic theory, antennas, quantum electronics, plasmas, signal processing and recognition, radio astronomy, energy conversion, high-voltage phenomena, thin-film circuits, and biomedical electronics.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry	2623	2	–	–	–
Calculus and Differential Equations	2421	2	2	2	2
Dynamics	352, 353	2	1½	1	1½
Economics	2720	2	–	2	–
Circuit Theory I	710	3	2	3	2
Electric and Magnetic Fields	711	2		2	
Electrical Measurements	712	–	–	2	–
Electrical Laboratory	713	–	3	–	3
Mechanics of Materials	106, 104	2	3	1	–
Physics II	2526	–	–	2	3
Programming and Numerical Methods	721	1	–	1	–
Practical Experience	20	–	–	–	–

Third Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Applied Mathematics	732	2	2	2	2
Circuit Theory II	733	3	–	2	–
Electric Machinery I	734	2	–	1	–
Electronic Circuits I	737	–	–	2	–
Electrical Problems	736	–	4	–	4
Electrical Laboratory	735	–	3	–	3
Electronics Laboratory	738	–	–	–	3
Heat Engineering Laboratory	318	–	3	–	–
Machine Design	367, 368	2	3	–	–
Physics of Metals	819, 820	–	–	2	1½
Physical Electronics	730	2	–	2	–
Thermodynamics	317	2	–	1	–
Practical Experience	20	–	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 7	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Computer Logic and Design...	781	2	–	1	–
Control Systems.....	765, 767	2	1½	2	1½
Electronic Circuits II.....	768, 769	3	3	–	–
Electric Machinery II.....	763, 764	2	3	–	–
Electromagnetic Theory I.....	762	2	1	2	1
Engineering Law.....	3440	1	–	–	–
English.....	2140	1	–	1	–
Fluid Mechanics.....	346	1	–	2	3
*Network Theory.....	772	–	–	2	1
Philosophy of Science.....	2040	2	–	–	–
Thesis.....	40	–	–	–	–
Practical Experience.....	20	–	–	–	–
And one subject from each of Groups A, B, and C.					
Group A					
Communication Systems.....	770, 771	–	–	3	3
Electric Power Systems.....	779, 780	–	–	3	3
Group B					
Electromagnetic Theory II....	776, 777	–	–	2	1½
Electric Machinery III.....	774, 775	–	–	2	1½
Group C					
Acoustics.....	792	–	–	2	1½
Illumination.....	794	–	–	2	1½
Quantum Electronics.....	784, 785	–	–	2	1½

*Commencing in the session 1968–69.

METALLURGY AND MATERIALS SCIENCE
(Course 8)

"Metallurgy and Materials Science" is the study of the production, structure, and properties of the engineering materials used in structures, machines and devices.

Modern technology makes increasingly severe demands upon both metallic and non-metallic solids; in fact, it is difficult to think of an engineering project whose basic limitations do not reside in the materials which are available. For example, aerospace travel requires materials capable of withstanding extremes of heat, cold and pressure; the utilization of nuclear energy is limited only by materials which can withstand the effects of radiation and high neutron flux, while the transistor and the computer depend upon materials having special electrical and magnetic properties. As industry expands, the metallurgist or materials engineer will be called upon to play an increasingly important role in the economy.

The course is designed to place primary emphasis upon the fundamental principles which underly the chemical, physical and mechanical properties of solids. In the fourth year, each student is assigned an experimental problem involving original work and, where possible, this is related to the actual research in progress in the department. The student is, therefore, introduced to the methods of research.

The department is equipped with the most modern facilities for the study of the structure of materials, including X-ray diffractions, electron beam microprobe, optical equipment, together with facilities for producing and measuring high temperatures, high vacuum furnaces, etc.

The subjects of instruction are shown in the following tables. In these tables, reference numbers have been assigned to the subjects referring to a more detailed description of each, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Analytical Chemistry	2624	1	3	1	3
Calculus	2420	2	1	2	1
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Inorganic Chemistry	617	1	–	2	–
Materials Science	832	2	–	2	–
Mechanics of Materials	105, 104	2	–	2	3
Physical Chemistry	801	1	–	1	–
Physics—Heat and Optics	2525	2	3	–	–
Probability and Statistics	2423, 2424	2	2	2	2
Practical Experience	20	–	–	–	–

Third Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry of Metals	802, 803	2	3	–	6
Differential Equations	2432	2	–	2	–
Engineering Data Processing	3331, 3332	–	–	2	3
Fluid Flow and Heat Transfer	341	2	–	2	3
Materials Processing	833	2	–	1	–
Physics of Metals	821, 822	2	6	2	3
Thermodynamics in Metallurgy	810, 812	2	4	2	4
X-ray Crystallography	2901	–	2	–	2
Practical Experience	20	–	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

Fourth Year Subjects Course 8	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Chemistry of Metals	805, 806	2	6	2	–
English	2140	1	–	1	–
Materials Science Seminar	826	–	3	–	3
Metallurgical Problems Laboratory	814	–	2	–	2
Philosophy of Science	2040	2	–	–	–
Physics of Metals	823, 824	4	3	4	3
Physical Chemistry of Materials	813	2	–	2	–
Practical Experience	20	–	–	–	–
Thesis	40	–	6	–	9

GEOLOGICAL ENGINEERING

(Course 9)

Geology is the science of the earth. It includes, in a large sense, all knowledge of the earth—its origin, history, structure, composition and mineral wealth—and the physical, chemical and biological processes that change the earth. It spans a wide range of sciences and requires a thorough grounding in mathematics and the basic science and engineering disciplines to aid in a proper understanding of the subject and its many applications. The various branches of geology include geophysics, which is concerned with the investigation of the earth, particularly its structure and composition, by the methods of experimental physics; geochemistry, which may be defined broadly to include all parts of geology that involve chemical changes; and geobiology which deals with the totality of living things on the earth's surface in geologic time.

The first three years of the course in Geological Engineering provide a broad education in the fundamentals of geology and its associated disciplines. In the fourth year the course concentrates on the study of Economic Geology—the application of principles and methods of geology in the discovery, examination, evaluation and production of mineral, fossil fuel and water resources. An option in the last year allows the student to choose between the subjects Exploration Geophysics (2568, 2569) and Mine Operation and Administration (224, 226) thereby emphasizing either the search for or the development of mineral deposits.

Graduation from this course leads to employment in mineral and petroleum exploration and development. Graduates are prepared for advanced study towards the M.A.Sc. and Ph.D. degrees in a number of branches of geology including Economic Geology, Geochemistry, Structural Geology and Applied Geophysics.

The subjects of instruction are shown in the following tables. The subject numbers refer to detailed descriptions in the succeeding pages, e.g., Economics, 2720, page 116.

For FIRST YEAR CURRICULUM—DIVISION A, see page 28.

Second Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Calculus	2420	2	1	2	1
Economics	2720	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	106, 104	2	–	1	1½
Mineralogy	2921	2	3	2	3
Mining	221	1	–	1	2
Optical Crystallography	2922	–	2	–	2
Physical Chemistry	2622	2	–	2	–
Principles of Geology	2920	2	2	2	2
Surveying	155, 156	1	1½	1	1½
Practical Experience	20	–	–	–	–

Third Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
Geological Field Trips	2937	–	–	–	–
Geology Field Camp	2936	–	–	–	–
Metallurgy	804	–	–	2	–
Mineral Identification Laboratory	2934	–	2	–	2
Petroleum Geology, Ground Water	2933	2	3	2	3
Petrology	2930	2	2	2	2
Photogrammetry	162, 163	2	3	–	–
Practical Experience	20	–	–	–	–
Stratigraphy and Sedimentation	2931	2	2	2	2
Structural Geology	2932	1	3	1	3
Survey Camp	158	–	–	–	–
Surveying Laboratory	156	–	1½	–	1½
Theory of Phase Equilibria	2935	2	–	2	
One of:					
*Differential Equations	2432	2	–	2	–
Mining Technology	222	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

*Prerequisite for Exploration Geophysics 2568, 2569 in the Fourth Year.

Fourth Year Subjects Course 9	Subject No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab.	Lect.	Lab.
English Literature	2140	1	–	1	–
Exploration Geochemistry	2943	1	3	1	3
Geological Data Analysis	2942	2	2	2	2
Geological Field Trips	2947	–	–	–	–
Metallurgy	808	1	–	1	–
Mineral Deposits	2940, 2941	2	3	2	3
Mineral Economics	2944	2	–	1	3
Philosophy of Science	2040	2	–	–	–
Thesis	40	–	6	–	6
And one of:					
Exploration Geophysics	2568, 2569	2	3	2	3
Mining	224, 226	2	3	2	3

AEROSPACE STUDIES

A five-year program of study is offered to prepare the student for a career in the aerospace field. It includes the following elements: (*a*) an introduction to the fundamentals of mathematics, physics, and chemistry, (*b*) an introduction to aerodynamics, instrumentation, propulsion, structures and design, and (*c*) an advanced treatment of the subjects required for modern design and research in aerospace science and engineering such as hypersonic aerodynamics, flight dynamics, and space propulsion. Under (*a*) and (*b*) the student's training is necessarily broad and basic. The more advanced knowledge needed for the research, development, and design relevant to new aircraft and spacecraft is provided under (*c*) and is of particular significance. Parts (*a*) and (*b*) are provided in a four-year undergraduate course, but the final intensive training under (*c*) is left for a postgraduate (fifth) year.

The program of study that leads to status as a well-qualified aerospace engineer has been established in two parts as follows:

(i) *Undergraduate Course.* The student registers in the course in Engineering Science, subject to the entrance requirements given on page 16 of this Calendar. This course provides the requisite training in the fundamental sciences (see (*a*) above). The advanced subjects contained in the Aerospace option given in the third and fourth years are taught by the staff of the Institute for Aerospace Studies (see (*b*) above). The student will receive the degree of Bachelor of Applied Science upon completion of this part of the program.

(ii) *Graduate Course.* The student will then continue his five-year program (see (*c*) above) in the Institute for Aerospace Studies, as a candidate for the degree of Master of Applied Science or Master of Engineering. Details regarding entrance regulations and courses of study are given in the Calendar of the School of Graduate Studies. The facilities of the Institute are available to the student. For details of research projects, assistantships, scholarships and demonstratorships, students should consult the Annual Bulletin of the Institute.

It should be noted that a student who has graduated in another branch of engineering and who desires to qualify as an aerospace engineer may proceed directly with (ii) above, but in this case the course leading to the M.A.Sc. or M.Eng. degree must be arranged so that deficiencies in his undergraduate training are made up.

The facilities of the Institute are available for further graduate study leading to the Ph.D. Degree.

OUTLINE OF LECTURE AND LABORATORY SUBJECTS

On the pages that follow a brief description is given of the lectures and laboratory subjects prescribed in the preceding tables of curriculum. The numbers before the subjects are the reference numbers assigned in the tables.

Where laboratory reports are to be written outside of assigned laboratory hours the maximum number of such reports is indicated in the description of the laboratory course concerned.

INTERDEPARTMENTAL SUBJECTS

11. Engineering Seminars. The Professorial Staff in Engineering.

All courses, I Year; 6 one-hour discussions each term. Seminar groups will be very small.

A discussion of topics such as: the solution of practical engineering problems; problems arising from courses taken in the First Year; the prosecution of engineering research.

12. Introduction to Computer Programming. The Staff in Engineering and the Staff in Computer Science.

All courses, I Year; 1 hr. lecture and 1 hr. problems per week, second term.

Introduction to algorithms and stored-programme computers; FORTRAN programming; applications to numerical and non-numerical programmes.

13. Engineering Applications of Mathematics. The Staff in Engineering.

Courses 1, 3, 4, 6, 7, 8, 9, I Year; 2 hrs. problems per week, first term; 1 hr. problems per week, second term.

Problems will be assigned to illustrate engineering applications of mathematics. These problems will be based on the contents of the First Year courses in Chemistry, Physics, and Mathematics, and will be selected to illustrate how the same mathematical models and procedures may enter into diverse applications involving different physical and chemical principles.

20. Practical Experience.

Students in the courses listed below are required to have, before graduation, practical work of a nature acceptable to the department concerned. This may be obtained during the summer vacations but work done before entering the Faculty may also meet the requirements. Instructions will be issued by the departments concerning the type of work which is acceptable. Practical experience certificate forms may be obtained from the departments and should be returned there when completed.

Course 1	600 hours
Course 3	600 hours
Course 4	600 hours
Course 6	600 hours
Course 7	600 hours
Course 8	600 hours
Course 9	600 hours

40. Thesis

All courses, IV Year.

Every student in the Fourth Year is required to prepare a thesis on an approved subject. Instruction will be issued by the departments concerned.

In some cases written presentation is required, in others oral and written, or it may consist of a research problem followed by a written thesis or report.

DEPARTMENT OF CIVIL ENGINEERING

100. Applied Mechanics. Staff in Civil Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms; 6 three-hour problems laboratories during the session.

This subject is divided into two parts, statics and dynamics.

Statics: The principles of statics are discussed, and applied to the composition and resolution of forces. A variety of applications are studied, including plane pin-jointed frames and simple three-dimensional structures.

Dynamics: Theoretical principles and practical applications are discussed for:

Particle motion on straight and curved paths; work energy and power; impulse and momentum; plane translation and rotation of rigid bodies.

Textbook: *Mechanics for Engineers*—Beer and Johnston; *Statics and Dynamics*—J. L. Meriam.

101. Statics. J. Schwaighofer.

Course 5, I Year; 2 hrs. lectures per week, first term.

Translational and rotational resultants and equilibrants are discussed together with equivalent force systems in two- and three-dimensional space. Emphasis is placed on systems in equilibrium. A variety of applications is studied including frameworks, simple machines, and bending moments and shearing forces in beams.

Textbook: *Mechanics for Engineers: Statics*—Beer & Johnston (Second Edition).

102. Mechanics of Materials. K. Meipoom, J. Timusk, R. Tress.

Courses 4 and 6, II Year; 2 hrs. lectures per week, both terms.

In this subject, the fundamental theories of stress and strain are investigated as they apply to the selection of adequately proportioned materials to carry a given load in such engineering applications as tension, compression, torsional, and other members.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Schneider.

103. Mechanics of Materials. J. Schwaighofer.

Course 5, II Year; 1 hr. lecture per week, both terms.

Basic relationships between force, stress, strain, and deflection of bodies made of various engineering materials are discussed. Beams, columns, shafts, tension members and pressure vessels are analysed and designed for strength and stiffness.

Textbook: *Mechanics of Materials*—Popov.

104. Mechanics of Materials Laboratory. J. D. Barber, C. E. Helwig, K. Meipoom, R. G. Tress.

Courses 1, 3 and 8, II Year; 3 hrs. laboratory per week, second term.

Courses 4 and 7, II Year; 3 hrs. laboratory per week, first term.

Course 9, II Year; 3 hrs. laboratory, alternate weeks, second term.

An introduction to testing machines, strain and other measuring devices and standard specifications.

The experimental study of some engineering materials and structural members under applied load.

No laboratory report shall be written outside the assigned teaching hours.

105. Mechanics of Materials. J. D. Barber.

Courses 1 and 8, II Year; 2 hrs. lectures per week, both terms.

An introduction to the elastic and inelastic behaviour of solids under various external loading conditions. Strains, stresses and deformations are determined for members subjected to tension, compression, torsion and bending and for pressure vessels by using basic strength of materials theories.

Textbook: *Mechanics of Materials*—Popov.

106. Mechanics of Materials. A. C. Davidson.

Courses 7 and 9, II Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

The fundamental relations among stress, strain and applied load are worked out for tension, compression, twisting and bending in the elastic and inelastic ranges, for various engineering materials. Buckling phenomena are examined for struts and columns. Numerical applications are done in lectures; and problems are assigned for study.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Snyder.

107. Mechanics of Materials. A. C. Davidson.

Course 3, II Year; 3 hrs. lecture per week, first term; 1 hr. lecture per week, second term.

In this subject the following are examined: behaviour of materials under applied loading or deformation; stress-strain relations for elastic bodies; simple tension, compression, torsion and bending of engineering components; inelastic behaviour, instability of structural and mechanical systems; engineering properties of materials; mechanical testing to obtain measures of ductility, strength and other engineering properties; yield flow and fracture of metals; fluctuating stresses, stress concentration and fatigue. Mohr's circle will be used in a number of stress relationships.

Textbook: *Engineering Mechanics of Deformable Bodies*—Byars and Snyder.

110. Mechanics and Materials II. J. Schwaighofer, J. Timusk.

Course 1, Group A, III Year; 2 hrs. lectures per week, both terms.

Cement and concrete technology; an introduction to the design and analysis of reinforced concrete members; behaviour of metals;

special topics on bending of beams; failure theories; introduction to experimental stress analysis. Problems and laboratory under Course 113.

Textbooks: *Reinforced Concrete Fundamentals*—Ferguson; Concrete Manual by U.S. Bureau of Reclamation. *Mechanics of Materials*—Popov.

Reference book: *Concrete Technology I & II*—D. R. Orchard.

111. Structural Design I. M. W. Huggins.

Course 1, III Year; 2 hrs. lectures per week, both terms.

An elementary study of the stress analysis and design of structures, structural members, and their details.

The work covered includes steel and timber tension members, compression members and flexural members, including plate girders and continuous as well as simple span beams. Welding, riveting and high tension bolting, as methods of connecting structural members, are studied. Design and analysis problems under Course 113.

Textbook: *Design of Steel Structures*—Gaylord and Gaylord.

Reference books: *Structural Problems*—Young and Morrison. *Plastic Design of Steel Frames*—Beedle. National Building Code of Canada.

112. Structural Theory I. C. F. Morrison.

Course 1. Group A, III Year; 3 hrs. lectures per week, second term.

The stress analysis of simple span, continuous and cantilever trusses. Influence lines and index stresses. Truss deflections by analytical and graphical methods. Analysis of statically indeterminate trusses, beams and frames by various methods.

Problems under Course 113.

Textbook: *Structural Analysis*—Jack C. McCormac.

113. Structural Laboratory. Staff in Civil Engineering.

Course 1, Group A, III Year; 7½ hrs. per week, first term, 6 hours per week, second term.

Problems and laboratory to complement subjects 110 and 112.

Study periods of design and analysis to complement subject 111; during the fall term two timber structures and during the spring term one steel structure are designed. The designs are discussed and evaluated.

Three hours per week of the above time in the first term will be devoted to the cements and concrete laboratory; the balance will be on problems and design.

115. Structural Laboratory. J. Barber.

Course 1, Group B, III Year; 3 hrs. alternate weeks in first term, and 3 hrs. per week, second term.

Design and analysis problems to complement subject 111.

116. Reinforced Concrete I. S. M. Uzumeri.

Course 1A, IV Year; 2 hrs. lectures and 1½ hrs. problems per week, first term, and 2 hrs. lectures and 1 hr. problems per week, second term.

Course 1C, IV Year; 2 hrs. lectures and 3 hrs. problems and testing laboratory, both terms.

Ultimate and working strength behaviour of Reinforced Concrete members subjected to flexure, axial compression, shear, combined axial compression and flexure, combined flexure and shear, and bond.

Relation between research results and current specifications for design of members.

Design of simple and continuous beams, one way, two way and flat slabs, columns, retaining walls and footings.

Reference books: *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

117. Reinforced Concrete II. M. W. Huggins.

Course 1A, IV Year; 2 hrs. lectures and 1 hr. problems per week, both terms.

Ultimate design; prestressed concrete; composite design; design of building frames, arches and bridges. Behaviour of reinforced concrete members.

Reference books: *Theory & Practice of Reinforced Concrete*—Dunham. *Reinforced Concrete Design*—Sutherland and Reese. *Reinforced Concrete Fundamentals*—Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Nilson.

118. Behaviour and Design of Steel Structures. D. J. L. Kennedy.

Course 1A, IV Year; 2 hrs. lectures and 2 hrs. problems per week, both terms.

A continuation of Course 111. The behaviour of structural elements and structures is discussed and related to design methods and criteria. Topics include, repeated loading, brittle fracture, welding, connections, buckling, inelastic behaviour, analysis and design of metal structures by ultimate load procedures.

Textbooks: *Structural Steel Design*—Beedle *et al. Canadian Institute of Steel Construction*—Steel Construction Series, Books 1, 2, 3.

119. Structural Theory II. G. Kani, R. A. Collins.

Course 1A, IV Year; 2 hrs. lectures and 2 hrs. problems per week, first term; 3 hrs. lectures and 2 hrs. problems per week, second term.

Analysis of statically indeterminate structures; influence lines for statically indeterminate structures; the use of strain energy, slope deflection, moment distribution, column analogy and Kani methods for the analysis of frameworks; elementary aspects of matrix formulation of the analysis of statically determinate and indeterminate plane structures; an introduction to plate theory.

120. Thesis Project and Mechanics of Materials Laboratory. Staff in Civil Engineering.

Course 1A, IV Year; 4 hrs. per week, both terms.

Project and Mechanics of Materials laboratory to supplement courses 116, 117 and 118.

122. Structural Engineering II. C. E. Helwig.

Course 1B, IV Year; 2 hrs. lectures and 4½ hrs. laboratory and problems per week, first term; 2 hrs. lectures and 3 hrs. problems per week, second term.

Cements and concrete; design and analysis of reinforced concrete members. Design and analysis problems. In the first term 3 hours per week will be devoted to Cements and Concrete laboratory.

Textbook: *Design of Reinforced Concrete Structures* (Seventh Edition)—Winter, Urquhart, O'Rourke, Wilson.

126. Structural Engineering. J. D. Barber.

Course 3, IV Year; 2 hrs. lectures per week, first term.

The fundamental principles of Statics and Mechanics of Materials are applied to the design and analysis of structural members and their connections. Problems are worked in class and in the drafting room (Subject 127).

Moving loads on simply supported beams; tension, compression and flexural member details.

Textbooks: *Design of Steel Structures*—Gaylord & Gaylord; *Essentials of Structural Design*—Hoadly.

127. Structural Engineering Problems. J. D. Barber.

Course 3, IV Year; 3 hrs. per week, first term.

Problems supplementing the work covered in lecture course 126.

130. Construction Management and Business. K. A. Selby, G. T. Gilbert.

Course 1, IV Year; 2 hrs. lectures per week, second term.

A study of heavy and building construction, including job planning and organization, construction methods and equipment, superintendence, job records, labour relations and safety procedures. Elements of business organization and management with an introduction to the principles of control through accounting records and financial statements.

135. Engineering Graphics. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, W. E. Carswell.

All courses, I Year; 1 hr. lecture and 3 hrs. laboratory per week, both terms.

An introductory course designed to give the student a foundation in spatial visualization and an appreciation of the various graphical techniques used in representation and in the solution of engineering problems. The lectures are mainly concerned with descriptive geometry, i.e., with the principles of orthographic, oblique and perspective projection and their use in solving

problems involving points, lines and surfaces. In the laboratory, problems are solved in descriptive geometry, engineering drawing, empirical equations, charts and graphs. Both instrument and free-hand techniques are used.

Textbooks: *Graphic Science*—French and Vierck, 2nd edition; *Graphic Science Problems*—Vierck and Hang, 2nd edition.

137. Engineering Problems and Drawing. H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, P. Wodzianski.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 6 hrs. per week, both terms.

Drawing and lettering. Problems in descriptive geometry and applied mechanics. An introduction to graphical methods of solving engineering problems, e.g., nomography, empirical equations, graphical algebra and calculus, projective geometry.

Textbook: *Engineering Drawing*—French and Vierck, 10th edition.

138. Engineering Graphics. C. A. Wrenshall, V. P. Borecky.

Course 1, II Year; 4½ hrs. laboratory per week, first term; 4 hrs. laboratory per week, second term.

Problems in descriptive and projective geometry, nomography, graphical calculus. Graphs and empirical equations. Structural drawing. Plotting of original surveys.

Textbook: *Engineering Drawing*—French and Vierck, 10th edition.

139. Engineering Mathematics Problems. I. C. Medland.

Course 1, III Year; 3 hrs. per week, alternate weeks first term, 3 hrs. per week, second term.

Problems based on the content of Lecture Course 141.

140. Mathematical Applications. R. A. Collins.

Courses 1A, 1C, IV Year; 2 hrs. lectures and 1½ hrs. problems per week, second term.

The formulation, discussion and solution of certain civil engineering problems by numerical methods including relaxation techniques. Electronic digital computers are employed in appropriate cases.

141. Engineering Mathematics. I. C. Medland.

Course 1, III Year; 2 hrs. lectures per week both terms.

The solution of differential equations and their application in Civil Engineering.

Textbook: *Applied Differential Equations*—Spiegel.

145. Computer Programming. R. A. Collins, K. A. Selby.

Course 1, II Year; 2 hrs. lectures per week, 2 hrs. laboratory per week, first term.

The following topics are discussed: algorithms; number systems; components of a stored-program digital computer; programming techniques, with particular emphasis on flow-charts; types of languages; number representation in a computer; addressing.

The Fortran IV language, as an example of an algebraic language, is studied extensively from a user's point of view. Problem-oriented languages for Civil Engineers, such as COGO and STRESS, are introduced.

Programming exercises accompany all instruction in flow-charting and languages.

152. Engineering Optics and Astronomy. V. L. Henderson, H. Macklin.

Course 1, II Year; 1 hr. lecture per week, first term; 1 hr. lecture per week and 3 hrs. laboratory every second week, second term.

Reflection and refraction at plane and curved surfaces; optical instruments—telescope, microscope; physical optics.

Solution of spherical triangles; star co-ordinate systems; motions of celestial bodies; determination of azimuth, position and time using engineering instruments.

153. Surveying. O. J. Marshall, B. J. Haynes, H. L. Macklin.

Course 1, II Year; 2 hrs. lectures and 4 hrs. laboratory per week, first term; 1 hr. lectures and 3 hrs. laboratory per week, second term.

General principles and practise of surveying including: discussion of instruments for measurement of horizontal distances (tapes and electronic devices) horizontal and vertical angles (transit and theodolite) vertical distances (level and rod). Survey calculations, adjustments and corrections, including azimuths, bearings, latitudes, departures, co-ordinates and areas. Simple, compound and reverse curves as used in Highway, Railroad and Cadastral surveying. Construction surveying dealing with cross-sections, earthwork quantities, vertical curves.

Laboratory periods for practical applications to illustrate the above topics, first term on field problems, second term on calculations.

Textbooks: *Surveying*—Philip Kissam; *Route Surveys*—Skelton.

155. Surveying. H. L. Macklin.

Course 9, II Year; 1 hr. lecture per week, both terms.

Introduction to surveying principles and practice. Theory and use of surveying instruments. Survey computations and error analysis, including quantity calculations. Mine surveys, topographic surveys, and introduction to practical astronomy.

Textbooks: *Surveying Practice*—Kissam; *Surveying for Civil Engineers*—Kissam.

156. Surveying Laboratory. H. L. Macklin.

Course 9, II Year; 3 hrs. per week, alternate weeks, both terms.

First term—field problems using the transit, level and tape.

Second term—survey computations related to Course 155.

158. Survey Camp. Staff in Civil Engineering.

Course 1, III Year; Aug. 14 to Sept. 15—Dorset or Gull Lake;

Course 9, III Year; Sept. 5 to Sept. 15—Gull Lake.

Course 1:

(*a*) Secondary Triangulation and Base Line Measurements.

(*b*) Highway Location, Cross Sectioning and Earthwork Computations.

(*c*) Stadia and Plane Table Topography.

(*d*) Distance Measurements by Electronic Methods.

(*e*) Air Photo Interpretation.

(*f*) Observations for Time, Azimuth, and Latitude.

Course 9:

(*a*) Topographic Surveying and Mapping.

(*b*) Underground Surveying, including Shaft Plumbing and Use of Mine Surveying Instruments.

(*c*) Route Surveys, Curve Layout, and Earthwork Quantity Computations.

(*d*) Astronomic Observations for Time and Azimuth.

Students in Courses 1 and 9 will be required to take the Survey Camp between the Second and Third Years.

Application to defer attendance at the Camp must be made to the Secretary of the Faculty before July 15.

159. Least Squares. H. L. Macklin.

Course 1B, III Year; 3 hrs. laboratory per week, first term.

The general principles of probability of errors, elementary problems illustrating the application of Least Squares to the adjustment of observations, empirical constants and formulae.

No laboratory reports shall be written outside the assigned teaching hours.

Textbooks: *Survey Adjustment and Least Squares*—H. F. Rainsford. *Engineering Measurements*—B. Austin Barry.

160. Geodetic Engineering. O. J. Marshall.

Course 1B, III Year; 2 hrs. lectures per week, second term.

Principles, equipment and methods of geodetic survey involving triangulation, traverse and levelling of high precision; elementary geodesy and map projections.

161. Geodetic Engineering Laboratory. O. J. Marshall, B. J. Haynes.

Course 1B, III Year; 3 hrs. per week, second term.

Problems and computations supplementing the work covered in subject 160.

162. Photogrammetry I. J. Vlcek.

Courses 1B and 9, III Year; 2 hrs. lectures per week, first term.

Photograph as central projection, interior geometry of surveying camera, stereoscopic vision and methods of viewing stereo, methods of terrestrial photogrammetry, aerial photography, geometry of single picture, radial line triangulation, geometry of stereo-pairs, theory and practice of reconstruction of spatial models, plotting instruments, introduction to analytical methods.

163. Photogrammetry I. Laboratory. J. Vlcek.
Courses 1B and 9, III Year; 3 hrs. per week, first term.
Laboratory work supplementing the lecture course 162.

164. Photo Interpretation. S. G. Bird.
Course 1B, III Year; 2 hrs. lectures per week, second term.
The principles of interpretation of aerial photographs; geological processes of formation of landforms, both consolidated and unconsolidated, with particular emphasis on Pleistocene geology; the patterns of landforms as seen on aerial photographs; their identification and evaluation, and the engineering problems involved; location of granular material; soil mapping; drainage area delineations; highway, powerline, pipeline and flood control structure investigations; classification of muskeg and prediction of depth; selection of photo control points and optimum monumentation sites; optimum locations of trial survey lines; tree species identification.

165. Photo Interpretation Laboratory. S. G. Bird.
Course 1B, III Year; 3 hrs. per week, second term.
Laboratory work supplementing the lecture course 164.

167. Survey Camp. O. J. Marshall, H. L. Macklin, R. C. Gunn.
Course 1B, IV Year; Aug. 21 to Sept. 15, Gull Lake.
Triangulation, trilateration, electronic distance measurements, traverses, levelling and astronomical observations by precise methods.

168. Geodetic Adjustments. R. C. Gunn.
Course 1B, IV Year; 1 hr. lecture and 3 hrs. problems per week, both terms.
The theory of adjustment of geodetic measurements. The adjustment of triangulation, trilateration and level nets. The variance of the observed and the adjusted quantities. Curve fitting, and the application of the electronic computer to survey problems.
Adjustment of observations. Solution of problems by desk calculation and electronic computer.

170. Photogrammetry II. J. Vlcek.
Course 1B, IV Year; 1 hr. lecture and 3 hrs. laboratory per week, first term; 1 hr. lecture and 1½ hrs. laboratory per week, second term.
Review of elementary matrix theory, orthogonal and skew-symmetric matrices, theory of model restitution, linear conformal transformations in 2-space and 3-space and their applications in photogrammetry, methods of serial triangulation, non-linear transformations in 2-space and 3-space and their applications in the adjustments of strips and blocks of models, analytical model reconstruction.
Laboratory work consisting mainly of computer programming of photogrammetric problems.

172. Astronomy. H. L. Macklin, R. C. Gunn.

Course 1B, IV Year; 1 hr. lecture and 3 hrs. problems per week, second term.

Precise determination of time, latitude, longitude and azimuth as applied to geodetic surveys. Observations and problems.

174. Engineering and Legal Surveys. B. J. Haynes.

Course 1B, IV Year; 1 hr. lecture per week, first term, and 2 hrs. lectures per week, second term.

Construction surveying problems dealing with prismoidal volumes and corrections, hydrographic surveying, tunnel surveying, circular curve intersections, area computations, chronological order of land subdivision and layout from early township patterns to present-day subdivisions, the weighing of survey evidence in the retracement of construction and legal surveys, and the preparation of legal surveys.

175. Geodesy and Electronic Surveying. R. C. Gunn.

Course 1B, IV Year; 2 hrs. lectures and 1½ hrs. problems per week, first term; 2 hrs. lectures and 3 hrs. problems per week, second term.

Ellipsoidal geometry, deflections of the vertical, reduction of geodetic measurements to the ellipsoid, geodetic position computations, electronic surveying, map projections.

Problems in geodetic computations, the reduction of electronic distance measurements, the calculation of geodetic positions, map projection co-ordinates.

180. Sanitary Engineering. A. P. Bernhart.

Course 1, III Year; 2 hrs. lectures per week, first term.

The objective of Sanitary Engineering and Pollution Control. Basic outline of problems of urbanization and the natural cycle of water. Water Purification. Treatment of domestic and industrial waste waters. Municipal Services—water mains, sanitary sewers, storm water drainage, garbage disposal. Air Pollution Control—equipment and planning considerations.

181. Pollution Control Sciences. P. H. Jones and G. W. Heinke.

Course 1C, IV Year elective; 3 hrs. lectures, 2 hrs. laboratory per week, first term.

A lecture and laboratory course designed to relate the basic sciences with their application in waste water and water treatment.

Subject matter dealt with includes: Chemistry, Microbiology, Theory of Settling, Filtration, Coagulation, Ecology.

182. Municipal Engineering. G. W. Heinke.

Course 1C, IV Year elective; 3 hrs. lecture, 2 hrs. laboratory per week, second term.

Quantities of Water and Waste Water, Hydrology, Waste Water Collection System, Water Distribution Systems, Municipal Roads, Refuse Disposal, Administration and Financing of Municipal Works.

Laboratory: Design Problems supplementing lecture material.

Textbooks: *Water and Waste Water Engineering*—Fair, Geyer and Okun, Volume I. *Design and Construction of Sanitary and Storm Sewers*—WPCF Manual.

References: *Water Supply and Pollution Control*—Clark and Viessman. *Hydrology for Engineers*—Linsley, Kohler and Paulhus.

183. Pollution Control Engineering. A. P. Bernart.

Course 1C, IV Year elective; 3 hrs. lectures, 2 hrs. laboratory per week, second term.

Air Pollution Control, Water Supply and Purification, Municipal Waste Water Treatment, Industrial Waste Water Treatment, Soil Pollution Control.

184. Environmental Planning. A. P. Bernhart.

Course 1C, IV Year elective; 3 hrs. lectures, 2 hrs. laboratory per week, second term.

Environmental planning: physical, economical, biological, sociological, spiritual; new theory based on the philosophy of seven dimensions; emerging form of urban life; shaping the metropolis; metropolis within the region; green belts and satellites; pollution control; redevelopment.

185. Highway Engineering. M. M. Davis.

Course 1, III Year; 2 hrs. lectures per week, first term.

Organization, administration, economics and planning of rural highways; highway materials and paving; principles of location, design, construction and maintenance.

Textbook: *Highway Engineering*—Oglesby and Hewes, 2nd Edition.

Reference books: *The Highway Improvement Act—Ontario Highway Standards and Specifications*—Department of Highways of Ontario. *Soil Mechanics for Road Engineers*—D.S.I.R.—H. M. Printer, *Policy on Geometric Design of Rural Highways*—A.A.S.H.O.

186. Municipal Planning, Administration and Transportation. M. M. Davis, H. L. Macklin, D. F. D. Pinker.

Course 1, III Year; 3 hrs. lectures per week, second term.

Contemporary concepts in urban and regional planning and their theoretical, practical and legal applications as applied in Canada.

Organization of municipal government, municipal finance, legislation governing municipal operation, role of the municipal engineer and private practitioner in public works, provisions of municipal services.

Urban and regional growth as affected by transportation, trends, demands, characteristics and capacities, co-ordination with land use and integration with other services.

187. Traffic Engineering. R. M. Soberman.

Course 1C, IV Year elective; 3 hrs. lectures, 2 hrs. laboratory per week, first term.

Urban transportation planning, traffic studies, forecasting models, characteristics of traffic flow, traffic control at intersections, methods of project evaluation.

Textbook: *Traffic Engineering Handbook.*

References: *Principles and Techniques for Predicting Future Demand for Urban Area Transportation*—Martin, Memmott, and Bone; *Highway Capacity Manual.*

188. Transportation Engineering. M. M. Davis, R. M. Soberman, R. G. Rice.

Course 1C, IV Year elective; 3 hrs. lecture, 2 hrs. laboratory per week, second term.

Characteristics of Transportation Systems, Railway and Airport Engineering, Theory of Traffic Flow, Behaviour and Design of Flexible and Rigid Pavements.

Reference books: *Introduction to Transportation Engineering* —Hay; *Planning & Design of Airports*—Horonjeff; *Soil Mechanics for Road Engineers*—D.S.I.R.; *Principles of Pavement Design*— Yoder; *Poisson & Traffic*—Eno Fndn.

189. Air Photo Interpretation. S. G. Bird.

Course 1C, IV Year elective; 3 hrs. lectures and 2 hrs. laboratory per week, first term.

The principles of interpretation of aerial photographs; processes of formation and erosion of landforms, both unconsolidated and consolidated, with particular emphasis on glaciation, their patterns as seen on aerial photographs, their identification and evaluation, and the engineering problems involved; location of granular materials; soil mapping; investigations from airphotos for highway, powerline, and pipeline locations, damsites and flood control structures; delineation of drainage areas and drainage structure location; classification of muskeg areas and prediction of depth; land use classification. One day field trip, including field soil testing.

191. Soil Mechanics. F. A. De Lory.

Course 1, III Year; 2 hrs. lectures per week, first term.

Identification and classification of soils for engineering purposes, weight volume relationships, compaction, permeability and drainage characteristics, effective stresses, shearing strength, site exploration and soil sampling, lateral earth pressure.

Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

192. Soil Mechanics and Foundations. F. A. De Lory, E. I. Robinsky.

Courses 1A and 1C, IV Year; 2 hrs. lectures per week first term; 1 hr. lecture per week and 2 hrs. laboratory per week, second term.

Shearing strength, bearing capacity, footings, consolidation and settlement, lateral pressures, retaining walls, braced cuts and

cofferdams, pile and caisson foundations, sheet pile bulkheads, slope stability, flow nets, dewatering.

Laboratory testing and problem periods. No laboratory reports to be written outside assigned laboratory hours.

Reference texts: *Foundation Design*—Teng; *Foundation Engineering*—Peck, Hanson and Thornburn.

193. Foundations and Earthworks. F. A. De Lory, T. C. Kenney.

Course 1C, IV Year elective; 3 hrs. lecture and 2 hrs. laboratory or problems per week, second term.

Design and construction of: Foundations for buildings, bridges and other structures including excavation, footings, piling, caissons; Retaining walls, sheet pile bulkheads, tunnels; Fills, embankments, earth-fill and rock-fill dams including seepage, dewatering and grouting. Geotechnical processes and field measurements and control.

194. Engineering Geology. E. I. Robinsky and Geology Department.

Course 1C, IV Year elective; 3 hrs. lecture per week, 2 hrs. laboratory per week, first term.

The study of engineering practice from a geological point of view. The behaviour of rocks and soils in building and engineering construction, foundations, tunnels, dams, and flood-control works with reference to the importance of the mineral composition of earth and rock materials, their geomorphic and geologic features and their stress history. Engineering case studies will include examination of groundwater, frost and landslide conditions, shoreline engineering, construction in permafrost, earthquake problems, and field investigations.

195. Soil Mechanics and Highway Laboratory. F. A. De Lory, E. I. Robinsky, R. M. Soberman.

Course 1, III Year; 3 hrs. per week, first term.

A series of laboratory and problem periods to accompany courses in Soil Mechanics (191) and Highway Engineering I (185).

DEPARTMENT OF MINING ENGINEERING

221. Mining. H. R. Rice, S. E. Wolfe.

Course 9, II Year; 1 hr. lecture per week, both terms, and 2 hrs. laboratory per week, second term.

A combined lecture and laboratory subject in the principles of mining and its unit processes. Emphasis is placed on the statistical approach to sampling calculations.

222. Mining Technology and Mineral Dressing. H. R. Rice, S. E. Wolfe.

Course 9, III Year; 2 hrs. lectures per week, both terms.

An introduction to mining practice with emphasis on current mining methods as applied to geological situations and stress environments; fundamental principles and current practices in mineral beneficiation processes.

224. Mine Operation and Administration. H. R. Rice.

Course 9, IV Year; 2 hrs. lectures per week, both terms.

Mine operation with special attention paid to mine services; administration dealing with aspects of economics, industrial engineering, finance, and industrial relations.

226. Mining Laboratory. H. R. Rice.

Course 9, IV Year; 3 hrs. laboratory per week, both terms.

Problems in mine layout involving shaft location and size; mine development; choice of stoping methods, mining rate, and mine equipment; time and cost schedules; ore reserve calculations.

DEPARTMENT OF MECHANICAL ENGINEERING

302. Engineering Thermodynamics. A. B. Allan.

Course 1, II Year; 1½ hrs. lectures per week, second term.

The fundamentals of engineering thermodynamics. The First and Second Laws. Properties of substances. Heat transfer. Heat exchangers. Compressors, fans, pumps, reciprocating engines and turbines. Vapour and gas power cycles. Refrigeration. Air-conditioning.

308. Heat Engineering. F. C. Hooper.

Course 3, III Year; 2 hrs. lecture per week, first term; 1 hr. lecture per week, second term.

A continuation of subject 303 and complementary to subject 309, this course deals with steam generators including combustion calculations, fuel and exhaust product analysis, and boiler testing and design; with internal combustion engines; with heat transmission; and with psychrometry and air conditioning.

Textbook: *Power Plant Theory and Design*—Potter.

Reference book: *A.S.H.R.A.E. Guide.*

309. Engineering Thermodynamics. F. C. Hooper.

Course 3, III Year; 2 hrs. lectures per week, both terms.

Continuation of subject 303.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer. Regeneration.

Textbook: *Elements of Thermodynamics and Heat Transfer*—Obert and Young.

310. Heat Engineering Laboratory.

Course 3, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subjects 303, 308 and 309. The experimental work, conducted on a broad range of heat and power equipment, is intended to offer experience in the design, organization and execution of experimental investigations of thermal apparatus, in the application and evaluation of

the associated instrumentation, in the treatment of the data, and in the interpretation and reporting of the work.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

311. Engineering Thermodynamics. W. J. Moroz.

Course 4, III Year; 2 hrs. lectures per week, second term.

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles used in practice for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer.

Textbook: *Thermodynamics of Heat Power*—Faires.

312. Heat Engineering Laboratory.

Course 4, III Year; 3 hrs. laboratory per week, second term.

This laboratory is complementary to lecture subject 311. Selected experiments are conducted in illustration of the methodology of experimental investigation of the external characteristics of thermal devices and systems, with special attention given to the peculiar interests of the engineer primarily concerned with economic considerations.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

313. Heat Engineering. W. J. Moroz.

Course 5nt, III Year; 1 hr. lecture per week, both terms.

This course consists of a study of the fundamental concepts of macroscopic thermodynamics, and their applications to closed and open dynamic systems. An examination of the principal power cycles is undertaken in relation to the properties of the working media involved. Emphasis is placed on a thorough understanding of the three basic laws of thermodynamics.

Textbook: *Concepts of Thermodynamics*—Obert.

Reference books: *Engineering Thermodynamics*—Hall and Ibele.

Thermodynamics—Van Wylen.

314. Heat Engineering Laboratory.

Course 5nt, III Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture subject 313. The course emphasizes the philosophy and techniques used in the experimental investigation of the performance of heat engineering equipment.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

317. Thermodynamics. A. B. Allan.

Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

A development of the fundamental laws of thermodynamics and of their application in engineering. Internal combustion and steam power, refrigeration, heat transfer, psychrometry and air conditioning.

Textbook: *Thermodynamics of Heat Power*—Faires.

318. Heat Engineering Laboratory.

Course 7, III Year; 3 hrs. laboratory per week, first term.

This laboratory is complementary to lecture subject 317. Particular emphasis is placed on the experimental determination of the control and output characteristics of prime movers and of the energy balances in heat power plants.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

322. Thermal Energy Conversion I. P. B. Hughes, D. G. Andrews.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

A continuation of subjects 308 and 309, and complementary to subject 323, this course deals with the plants and processes used in major power production. The overall design and heat balance in steam power plants is considered, and their components are examined. Both conventional fossil fuel and nuclear energy sources are considered. New developments and trends are introduced.

Textbook: *Power Plant Theory and Design*—Potter.

323. Thermal Energy Conversion II.

Course 3, IV Year; 2 hrs. lectures per week, second term.

A continuation of subjects 308 and 309, and complementary to subject 322, this course deals with non-central power production as for shaft power, propulsion, and similar applications. A survey of present and potential fuel resources. Operating cycles and characteristics of internal combustion engines, including reciprocating, rotary positive and gas turbine types. Rockets and ramjets. Design factors. The principles and potential of devices under current development, including fuel cells, thermoelectric converters and magnetohydrodynamic power generation.

Reference book: *The Internal Combustion Engine*—Taylor and Taylor.

324. Heat Engineering Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

This laboratory is complementary to lecture subjects 322 and 323. It is an extension of the third year laboratory, subject 310, with an increased demand for individual judgment and a professional outlook.

Textbook: *The Engineering Report in the Undergraduate Laboratory*—Hughes.

328. Heat Transfer. F. C. Hooper.

Course 5nt, IV Year; 2 hrs. lecture per week, second term.

Steady state and transient conduction, surface and gas radiation, convection, boiling, condensation and combined mechanisms are considered. Special attention is given to analogue and computational procedures and to consideration of the manner in which novel or complex problems may be approached.

Textbook: *Heat Transmission*—McAdams.

331. Thermal Energy Conversion. D. S. Scott.

Course 5nt, IV Year; 3 hrs. lectures per week, both terms.

The thermodynamics and gas dynamics of thermal energy conversion. Steam power cycles, nuclear reactor and fossil fuel energy sources, magnetohydrodynamic power generation, fuel cells, combustion, refrigeration, new trends and research developments.

332. Heat Engineering Laboratory.

Course 5nt, IV Year; 3 hrs. laboratory per week, both terms.

This laboratory is complementary to lecture course 331, and an extension of course 314. The techniques of testing, the design of experiments, the application of instrumentation, and the organization and reporting of performance tests are emphasized.

333. Fluid Mechanics. W. D. Baines.

Course 1, III Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.

Introductory concepts; fluid properties; dimensional analysis; fluid statics; kinematics and dynamics of flow; laminar and turbulent flow; applications to closed-conduit and open-channel flow; draw and lift on submerged bodies.

334. Fluid Mechanics. G. R. Lord.

Course 3, III Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.

Introductory concepts; fluid properties, dimensional analysis; hydrostatics; kinematics and dynamics of flow; irrotational flow and vorticity; dynamic lift; laminar flow solutions; turbulent flow; applications to closed-conduit and open-channel flow; drag; one-dimensional compressible flow.

337. Fluid Mechanics. B. D. Pratte.

Course 4, III Year; 2 hrs. lectures per week, first term; 3 hrs. laboratory per week, first term.

The fundamentals of fluid flow as generally encountered in industry; fluid properties; fluid statics; energy relationships; dimensional analysis and dynamic similarity; flow in pipes and channels; resistance of submerged bodies; effects of viscosity and compressibility; applications.

338. Fluid Mechanics. J. F. Keffer.

Courses 5c and 5nt, III Year; 2 hrs. lectures and 3 hrs. laboratory per week, both terms.

Presentation of fundamentals of continuum fluid motion; introductory concepts; kinematics and dynamics of flow; irrotational motion; viscous laminar and turbulent flow; thermodynamic relationships; gravity effects; applications.

339. Fluid Mechanics. I. G. Currie.

Course 6, III Year; 2 hrs. lectures per week, first term; 3 hrs. laboratory per week, first term.

Introductory concepts; fluid properties; fluid statics; kinematics and dynamics of flow; laminar and turbulent flow; closed-conduit and open-channel flow; compressibility effects; drag and lift on submerged bodies; elementary turbomachinery.

341. Fluid Flow and Heat Transfer. W. D. Baines, A. H. Abdelmessih.

Course 8, III Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.

A study of the forces and motion produced by various fluid properties. Gravitational, viscous and inertial forces are considered in detail. Momentum, energy and continuity relation, boundary-layer approximation, turbulence, flow in pipes and around submerged bodies.

Steady-state conduction in one dimension; extended surfaces; heat conduction with two or more independent variables; forced convection and dimensional analysis; heat transfer by free convection; radiant heat transfer; heat transfer by combined conduction and convection; heat transfer in liquid metals.

343. Hydraulic Engineering. H. J. Leutheusser.

Course 1, IV Year; 2 hrs. lectures and 3 hrs. laboratory per week, first term.

The general field of hydraulic engineering is studied under the topics: hydrology; ground and surface water; drainage, flood control, power and navigation systems; municipal and industrial applications; model studies; principles of design, operation, and field investigation.

344. Hydraulics. G. R. Lord.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

The general field of applied hydraulics and fluid mechanics is studied under the topics: hydrology; hydro-electric power plants and auxiliaries; conservation and flood control; canals, pipelines, etc., under both steady and unsteady conditions; hydraulic machinery, fans, compressors, turbines, pumps, etc., design, selection and operation; power and control circuits; flow of compressible fluids; similarity and model investigations; industrial applications.

345. Hydraulic Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, first term; 4½ hrs. laboratory per week, second term.

Experimental work is carried out in the laboratory on various

types of pumps, turbines, fans, centrifugal compressors and on hydraulic models. In addition computation problems involving open channel flow, water power studies, pumps and turbine studies, water hammer phenomena, fans and ductwork and other advanced flow problems are considered. General problems involving compressibility of gases are considered.

346. Fluid Mechanics. J. F. Keffer.

Course 7, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term; 3 hrs. laboratory per week, second term.

Presentation of fundamentals of fluid flow; introductory concepts; kinematics and dynamics of flow; potential flow; laminar and turbulent flow; applications.

350. Dynamics. G. E. Godfrey.

Course 1, II Year; 1½ hrs. lectures per week, second term.

Motion of a point is reviewed and extended to include Coriolis' acceleration, with applications. Equations for motion of mass in translation, rotation, and plane motion are developed, including centre of percussion. An introduction to vector mechanics is given. Moment of inertia of mass is studied by double integration and by the lamina method. The derivation and application of gyroscopic action is thoroughly discussed, and an introduction to static and dynamic balancing is given. Elementary vibration theory and problems in vibration isolation are discussed.

Textbook: *Engineering Dynamics*—Hooper and Smith.

Reference book: *Mechanics*—Part II—Meriam; *Engineering Mechanics*, Vol. II, Vector Edition, Higdon & Stiles.

351. Dynamics. B. H. Karnopp.

Course 3, II Year; 3 hrs. lectures per week, first term.

Calculus of vectors; particle motion; sytsems of particles; rigid bodies; virtual work and D'Alembert's principle; introduction to Lagrange equations; introduction to mechanical vibrations.

Textbook: *Housner and Hudson*—Applied Mechanics-Dynamics.

352. Dynamics. F. P. J. Rimrott.

Course 7, II Year; 2 hrs. lectures per week first term; 1 hr. lecture per week, second term.

Dimensional units; vectors; kinematics, rectilinear and angular motion, plane motion, projectiles, satellite orbits, rigid body concept, relative motion with respect to translating and to rotating vehicles; kinetics, force, d'Alembert's principle, rotation, translation, vibration of mechanical and electrical systems, work, energy, conservation of energy, power, impulse, momentum, rockets, jets, fluid mechanics, impact, balancing, centrifugal and Coriolis' force, critical speeds, gyroscopic effect.

Reference book: *Mechanics for Engineers, Dynamics*—Beer and Johnson.

353. Dynamics Laboratory.
Course 7, II Year; 1½ hrs. problems per week, both terms.
Problems in kinematics and kinetics to support subject 352.

356. Design of Machine Elements. R. T. Waines.
Course 3, II Year; 2 hrs. lectures per week, second term.
Standard methods for the design of belts, shafts, spur gears, bearings, brakes, clutches, couplings, power screws, fasteners, rivets and welded components.
Textbook: *Mechanical Engineering Design*—Shigley.

357. Design Laboratory. R. T. Waines.
Course 3, II Year; 3 hrs. per week, second term.
Design of machine parts and simple machines, including drafting and assembly layout. Fits, tolerances and metrology.

358. Theory of Machines. D. L. Allen.
Course 3, II Year; 2 hrs. lectures per week, second term; 3 hrs. laboratory per week, second term.
Equations for accelerated motion of mass applied to the analysis of machine elements. Velocity, acceleration, force distribution, speed fluctuation and balancing of machine parts and machines. Cams, gears, flywheels and linkage kinematics.
Textbook: *Kinematics and Dynamics of Machinery*—Maxwell.

363. Machine Design. I. W. Smith, R. T. Hartlen.
Course 3, III Year; 2 hrs. lectures per week, first term.
Static and dynamic stress analysis, failure theory, deflections, experimental stress analysis, behaviour of engineering materials, single degree of freedom vibrations.
Textbooks: *Mechanical Engineering Design*—Shigley. *Vibration Theory and Applications*—Thomson.
Reference: *Experimental Stress Analysis and Motion Measurement*—Dove and Adams.

364. Machine Design Laboratory.
Course 3, III Year; 6 hrs. per week first term; 3 hrs. per week second term.
Design and stress analysis of machine elements; creative design; problems and experiments in applied mechanics.

365. Applied Elasticity. G. E. Godfrey.
Courses 5nt, 5p, III Year; 1 hr. lecture per week, both terms.
Introduction (simple equations for normal and shear stresses; stress concentrations; fluctuating stresses and fatigue). Analysis of stress and strain in three dimensions, including use of primary and auxiliary Mohr's circles, and application to bending and torsion problems. Deflection analysis of statically determinate and indeterminate structures. Additional topics and applications include: Analysis of plates and shells, torsion of thin-walled tubes, stability of columns, thermal stresses.

366. Applied Elasticity Laboratory.

Courses 5nt, 5p, III Year; 3 hrs. laboratory per week, both terms.

Problems to support subject 365.

367. Machine Design. G. E. Godfrey.

Course 7, III Year; 2 hrs. per week, first term.

Force analysis; mechanics; velocities, accelerations and inertia forces in machines; principles of stress analysis and the design of various machine elements, including shafting, bearings, belts, gears, etc.; also an introduction to work on speed fluctuation, vibrations and balancing.

Textbook: *Mechanical Engineering Design*—Shigley.

368. Machine Design Laboratory.

Course 7, III Year; 3 hrs. per week, first term.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

373. Machine Design. I. W. Smith, B. Tabarrok.

Course 3, IV Year; 2 hrs. lectures per week, both terms.

Although the design of some specific machine elements is covered, such as springs, ropes and curved frames, most of the course is concerned with design concepts, including organization, reliability and creativity. An introduction to the field of theoretical mechanics includes elasticity, plasticity, thermal stress, vibrating systems and advanced kinematics.

Textbooks: *Mechanical Engineering Design*—Shigley. *Vibration Theory and Application*—Thomson. *Theory of Elasticity*—Timoshenko and Goodier.

374. Machine Design Laboratory.

Course 3, IV Year; 3 hrs. per week laboratory, first term; 4½ hrs. per week, second term.

Design and research projects utilizing the concepts given in Subject 373 and emphasizing the creative approach. Seminars on new developments in the design field are held.

375. Machine Design. G. E. Godfrey.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Force analysis; mechanics, velocities, accelerations and inertia forces in machine; stress analysis; deflections; failure theory; fluctuating stress, and design of various machine elements including shafts, bearings, belts, gears, riveted and welded parts, etc.; also an introduction to speed fluctuation and vibrations.

Textbook: *Design of Machine Elements* (third edition)—M. F. Spotts.

376. Machine Design Laboratory.

Course 4, IV Year; 3 hrs. per week, both terms.

Design and stress analysis of machine elements. In the laboratory, the student is given an opportunity to apply the subject material of the lectures to various machine design problems.

384. Numerical Methods. L. E. Jones.

Course 3, II Year; 2 hrs. lectures and 3 hrs. problems per week, first term.

Computational methods and procedures, including computer programming, leading to numerical solution of engineering problems involving interpolation, differentiation, integration, and solution of algebraic, transcendental and matrix equations.

386. Engineering Analysis. Staff in Mechanical Engineering.

Course 3, III Year; 1½ hrs. problems per week, first term; 3 hrs. problems per week, second term.

Exercises in reducing physical problems to analytical statements, with emphasis on the formulation of differential equations, the solutions of the mathematical problems involved, and the physical interpretation of these solutions; assessment of the validity of mathematical models.

Reference book: *Applied Differential Equations* (second edition)—M. R. Spiegel.

387. Treatment of Technical Data. L. E. Jones.

Course 3, III Year; 2 hrs. lectures per week, and 3 hrs. problems per week, second term.

Presentation of data; approximate nature of technical data; role played by mathematics; general numerical methods including FORTRAN computer language; methods of organizing data for computation; methods of analyzing technical data; elements of curve-fitting and statistical treatment.

390. Applied Mathematics in Engineering. L. E. Jones, A. H. Abdelmessih.

Course 3, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term; 3 hrs. problems per week, both terms.

Dimensional analysis and similarity, numerical methods, relaxation techniques, approximate solutions, digital and analogue computation, including FORTRAN computer programming, introduction to statistics and curve fitting.

Solutions of the heat conduction equation; steady one-dimensional systems; extended surfaces; applications of Fourier series to steady two-dimensional and transient systems; differential equations of Bessel and Legendre; steady-state and transient numerical methods.

391. Elementary Control Theory. J. VandeVegte.

Course 3, IV Year; 1 hr. lecture per week, both terms.

An introduction to the principles utilized in the analysis of linear control systems. Emphasis is also placed on the synthesis of mathematical models of simple systems, and the limitations inherently involved. Topics include stability criteria, characteristics of electrical, pneumatic and hydraulic control elements, and capabilities of feedback systems. A brief introduction to the problems arising from non-linear prototypes is included.

Recommended text: *Automatic Control Engineering*—Raven.

392. Elementary Control Theory Laboratory.

Course 3, IV Year; 3 hrs. laboratory per week, second term.

Problems and experiments related to subject 391.

393. Computational Methods. L. E. Jones.

Course 5nt, IV Year; 1 hr. lecture per week, 3 hrs. problems per week, both terms.

Practical extension of Subjects 2427 and 2428 to provide advanced computing experience with desk calculators and with analogue and digital computers. FORTRAN computer language will be studied in detail. Emphasis is placed on the economic use of available numerical procedures in the solution of engineering problems.

394. Control Engineering. J. VandeVegte, A. Porter.

Course 4, III Year; 2 hrs. lectures per week, both terms.

An introduction to the dynamic behaviour of linear systems; the feedback principle; the stability of linear control systems; the convolution theorem; transfer functions of linear systems; analysis and synthesis of linear control systems; introduction to servomechanism technology.

395. Control Engineering Laboratory. J. VandeVegte, A. Porter.

Course 4, III Year; 3 hrs. laboratory per week, both terms.

Problems and laboratory experiments to accompany subject 394.

396. Industrial Management. P. B. Hughes.

Course 3, IV Year; 1 hr. lecture per week, first term.

Introduction to principles of management and organization. Subjects 3440 and 396 are combined in one examination.

398. Control Systems. J. VandeVegte.

Course 5g, 5nt, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.

A course in linear and non-linear control systems.

399. Control Systems Laboratory.

Courses 5g, 5nt, IV Year; 3 hrs. laboratory per week, second term.

A laboratory course accompanying subject 398.

DEPARTMENT OF INDUSTRIAL ENGINEERING

401. Operations Research I. J. W. Abrams.

Course 4, IV Year; 2 hrs. lectures per week, both terms.

Methods of determining economic optima in industrial operations. Applications of mathematical techniques such as Lagrange multipliers, linear programming, non-linear programming, dynamic programming, to problems in production scheduling and sequencing, inventory control, transportation, equipment investment, utilization of scarce resources, and so on.

Recommended texts: *Concepts in Management Science*—Donald J. Clough, Prentice-Hall Inc.; *Methods and Models of Operations Research*—A. Kaufmann, Dunod, Paris (Vol. 1).

402. Operations Research I Laboratory. J. W. Abrams.

Course 4, IV Year; 3 hrs. laboratory per week, both terms.

Practical work to accompany subject 401. Case studies and problem assignments.

403. Operations Research II. S. Kotz.

Course 4, IV Year; 2 hrs. lectures per week, second term.

Applications of probability theory and statistical analysis to problems in industrial operations. Markov theory applied to queuing, inventory, maintenance, and machine replacement problems. Statistical methods of estimation applied to the same problem areas.

Recommended texts: *Concepts in Management Science*—D. J. Clough, Prentice-Hall, 1963; *Mathematical Methods in the Theory of Queueing*—A. Y. Khinchin, Griffin's Statistical Monograph, No. 17, 1964; *Elementary Decision Theory*—H. Chernoff and L. E. Moses, John Wiley & Sons, Ltd., 1959.

404. Operations Research II Laboratory. S. Kotz.

Course 4, IV Year; 3 hrs. laboratory per week, second term.

Practical work to accompany subject 403. Case studies and problem assignments.

405. Dynamics of Industrial Systems. R. W. P. Anderson.

Course 4, IV Year; 2 hrs. lectures per week, and 3 hrs. laboratory per week, first term.

The design and analysis of industrial systems, with particular emphasis on dynamic feedback models to simulate system behaviour.

407. Elementary Control Theory. A. Porter, I. R. Dalton.

Course 4, IV Year; 2 hrs. lecture per week, both terms.

The dynamic behaviour of simple linear mechanical and electrical networks; weighting functions and transfer functions of linear elements; the principles of analogue and digital computers;

introduction to Boolean Algebra and its applications; elements of information theory and its control implications; introduction to linear servomechanisms and manually operated control systems.

408. Elementary Control Theory Laboratory. A. Porter, I. R. Dalton.
Course 4, IV Year; 3 hrs. laboratory per week, both terms.
Problems and laboratory experiments related to subject 407.

410. Human Factors Engineering. P. J. Foley.
Course 4, IV Year; 2 hrs. lectures per week, second term.
A general introduction to the basic facts of physiology and experimental psychology, followed by a detailed study of the problems involved in the experimental analysis of human behaviour, with special reference to sensory systems.

411. Industrial Engineering Seminar.
Course 4, IV Year; 2 hrs. laboratory per week, both terms.
Invited speakers, prominent in the Academic, Governmental, and Business communities, will conduct a series of talks followed by general discussion. An essay based on one of these sessions will be required.

414. Elements of Industrial Engineering. T. C. Graham, A. Porter.
Course 4, II Year; 2 hrs. lectures per week, both terms.
A broad survey of both old and new elements of Industrial Engineering, with selected reading and essay assignments, including work study, wage determination, controls of production, quality and cost, mathematical models of production and distribution systems, computer simulation techniques, operations research, human factors studies, and management science.

415. Automatic Control of Processes.
Course 4, IV Year; 2 hrs. lectures per week, both terms.
Automatic control in the process industries and in the control of machine tools. Problems of on-line computer control. Relation to over-all problems of system planning and management control.

416. Human Factors Engineering. P. J. Foley.
Course 4, IV Year; 3 hrs. lecture/demonstration per week, both terms (beginning in the Session 1968–69).
A general introduction to the Bio-Sciences; detailed analysis of the structure and functioning of the central nervous system, and the special senses, in particular the visual phenomena which characterize man's interaction with his environment; application of this knowledge to selected problems in man-machine systems.
Readings will be assigned as the course progresses.

417. Industrial Engineering Seminar.
Course 4, IV Year; 2 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Members of the staff in Industrial Engineering, and invited speakers prominent in the academic, governmental, and business communities, will conduct a series of talks followed by general discussion. Two essays, on one or more of the subjects discussed, will be required.

418. Management Science. D. J. Clough.

Course 4, IV Year; 2 hrs. lecture per week, both terms (commencing in the session 1968–69).

Theories and methods of analysis to optimize product mix, process selection, equipment investment, production and distribution activity levels, competitive strategies, information flow and processing, organization, and control. Assessment of the accuracy, precision, and relevance of demand, cost, and technological data used in analyses, as obtained from designed industrial experiments, sampling, sample surveys, correlation of uncontrolled variables, and various internal and external agencies. Prerequisited are probability and statistics, linear algebra, and elementary differential equations.

Textbook: *Concepts in Management Science*—Donald Clough; Prentice-Hall.

419. Operations Research. Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lecture per week, and 3 hrs. laboratory per week, first term; 4 hrs. lecture per week, and 3 hrs. laboratory per week, second term (commencing in the session 1968–69).

Mathematical methods of operations research. Lagrange multiplier methods, linear and non-linear programming, dynamic programming, with assigned problems in production scheduling and sequencing, inventory control, transportation, machine replacement, and resource allocation. Systems of linear differential equations, complex variable theory, Markov theory, applied to queueing, inventory, maintenance, reliability, replacement, and information processing problems. Prerequisites are probability and statistics, linear algebra, and elementary differential equations.

A term test will be given at mid-session which will contribute 33% of the total course mark.

420. Systems Theories. Staff in Industrial Engineering.

Course 4, IV Year; 2 hrs. lectures and 3 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Theories of automata; information theory; organization systems theories; computer simulation models applied in the design and analysis of production and distribution systems and their concomitant control systems.

421. Thesis Project. Staff in Industrial Engineering.

Course 4, IV Year; 6 hrs. laboratory per week, both terms (commencing in the session 1968–69).

Design and analysis of an engineering system to satisfy certain objectives and requirements (e.g. the production of a specific product). This project will provide the student with an opportunity to apply the knowledge and techniques of analysis acquired in all the other Industrial Engineering subjects. The work will be carried out under the supervision of staff members. Progress reports and a written thesis are required.

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

600. Chemistry. The Staff in Chemical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms.

Chemical theory, with industrial and engineering applications.

601. Chemical Laboratory. W. F. Graydon, M. J. Phillips, S. Sandler, A. M. Rozeiu.

Courses 1, 3, 4, 5, 6, 7, 8 and 9, I Year; 3 hrs. laboratory per week, both terms.

A laboratory course illustrating the fundamental laws of chemistry as dealt with in the lecture course, and providing an introduction to chemical analytical methods.

602. Chemistry. W. H. Burgess.

Course 5, I Year; 2 hrs. lectures per week, both terms.

Introductory physical chemistry: the gas laws, chemical equilibria, elementary solution chemistry, thermochemistry. Problems dealing with industrial and engineering applications.

607. Engineering Chemistry. S. Sandler.

Course 1, II Year; 2 hrs. lectures per week, first term.

Corrosion and water-treatment; introduction to organic chemistry.

608. Physical Chemistry. R. W. Missen.

Course 5, II Year, 2 hrs. lectures per week, both terms.

The themes discussed are conservation, equilibrium and rate of change in chemical systems. These are applied to topics in thermochemistry, phase equilibrium, reaction equilibrium, including reactions in cells, and reaction kinetics.

Reference books: *Physical Chemistry*, by F. Daniels and R. A. Alberty, 3rd ed.; *Physical Chemistry*, by W. J. Moore, 3rd ed.

609. Physical Chemistry Laboratory. R. W. Missen.

Course 5, II Year, 3 hrs. laboratory, alternate weeks, both terms.

Experimental work and problems periods to accompany subject 608. In the second term, each student performs a laboratory investigation of an individual problem of a research type. Alternate periods are devoted to solving assigned problems.

613. Analytical Chemistry and Computation Laboratory. I. H. Spinner, M. E. Charles, J. Binkiewicz.
Course 6, II Year.
This course commences on the Wednesday following the first Monday in September, and continues until the opening of the Fall Term. All the working time will be spent on systematic quantitative inorganic analysis and machine computation.
Textbooks: *Textbook of Inorganic Analysis*—Kolthoff and Sandell; *A Guide to Fortran Programming*—D. D. McCracken.

614. Analytical Chemistry Laboratory. I. H. Spinner, W. A. M. Hewer, J. Binkiewicz.
Course 6, II Year; 9 hrs. laboratory per week, first term.
A continuation of Subject 613.

615. Analytical Chemistry. I. H. Spinner.
Course 6, II Year; 2 hrs. lectures per week, first term.
Equilibrium considerations in quantitative analysis.

617. Inorganic Chemistry. R. E. Jervis.
Courses 6, 8 and 9, II Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.
The constitution of matter and classification of the elements: systematic inorganic chemistry.

619. Chemical Engineering Science Laboratory. I. H. Spinner, W. A. M. Hewer, C. P. Brockett, M. J. Phillips.
Course 6, II Year; 7½ hrs. laboratory per week, second term.
Experiments illustrating the kinetic and equilibrium principles of chemical engineering. Mass and heat balance calculations.
One laboratory report per week.

620. Process Calculations. J. W. Smith, W. G. MacElhinney.
Course 6, II Year; 3 hrs. laboratory per week, both terms.
Process calculations in chemical engineering.
Textbook: *Basic Principles and Calculations in Chemical Engineering*—Himmelblau.

625. Reaction Kinetics. W. H. Burgess.
Course 6, III Year; 1 hr. lecture per week, both terms.
Chemical kinetics; principles of adsorption and colloid chemistry.

627. Chemical Laboratory. W. F. Graydon, Z. May.
Course 6, III Year; 6 hrs. laboratory per week, both terms.
A laboratory course to accompany subject 640.
One laboratory report.

628. Organic Chemistry. J. G. Breckenridge.
Course 6, III Year; 2 hrs. lectures per week, both terms.
An introductory course in organic chemistry.

629. Organic Chemistry Laboratory. W. H. Rapson, Z. May.

Course 6, III Year; 6 hrs. laboratory per week, first term; 9 hrs. laboratory per week, second term.

A laboratory course accompanying subject 628.

630. Industrial Chemistry. W. G. MacElhinney, W. H. Rapson.

Course 6, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Corrosion and selected chemical process industries. In preparation for this course, students will be expected to have read and to be thoroughly familiar with the following: *Chemical Process Industries*—Shreve: Chapters 29, 30, 31, 33, 34, 37.

631. Introduction to Mass and Heat Transfer. W. G. MacElhinney.

Course 6, II Year; 2 hrs. lectures per week, both terms.

The fundamental theory and practice used in transfer operations in chemical engineering. Energy and mass transfer are considered in the study of the flow of fluids, fluidization of solids, heat transfer, and evaporation of solutions.

Textbook: *Chemical Engineering*, Vols. I and II—Coulson and Richardson.

632. Fluid Mechanics. M. E. Charles.

Course 6, III Year; 2 hrs. lectures per week, second term.

Applications of the fundamentals of fluid mechanics in chemical engineering, with emphasis on single and two-phase flow with and without heat transfer, fluid-particle dynamics and non-Newtonian fluid flow.

Textbook: *Chemical Engineering*, Vols. I and II—Coulson and Richardson.

633. Applied Mathematics in Chemical Engineering. I. H. Spinner, R. W. Missen.

Course 6, III Year; 1 hr. lecture and 1 hr. problem period per week, both terms.

The first term is devoted to analysis and solution of chemical engineering problems which require knowledge of the rational design of experiments, treatment of experimental data and tests of hypotheses. The second term is devoted to applications of differential equations to problems of chemical engineering interest; emphasis is on the formulation of differential equations, together with their solution by analytical and numerical methods.

Reference Books: *Probability and Statistics for Engineers*—I. Miller and J. E. Freund. *Engineering Statistics*—A. H. Bowker and G. J. Lieberman. *Applied Differential Equations*—M. R. Spiegel.

640. Chemical Engineering Thermodynamics. W. F. Graydon.

Courses 5c and 6, III Year; 2 hrs. lectures and 2 hrs. problems per week, both terms.

A course in classical thermodynamics with problems in the field of applied chemistry and chemical engineering. Special emphasis is placed on chemical processes and compositional changes.

641. Chemical Engineering Rate Processes. O. Trass.

Course 5c, III Year; 2 hrs. lectures per week, both terms.

Introduction to mass, momentum and energy transport. Kinetic theory of gases, calculation of transport properties; analytical solutions of problems in viscous flow, heat conduction and mass diffusion; turbulent transfer coefficients; applications to chemical engineering systems.

Textbook: *Transport Phenomena*—Bird, Stewart and Lightfoot.

642. Chemical Engineering Problems and Laboratory. Staff in Chemical Engineering.

Course 5c, III Year; 9 hrs. per week, first term; 7½ hrs. per week, second term. Problems and laboratory experiments illustrating topics discussed in Subjects 640 and 641.

650. Mass Transfer Operations. O. Trass.

Course 6, III Year and Courses 5c and 6, IV Year; 2 hrs. lectures per week, both terms.

The theory and practice of mass transfer operations in chemical engineering are discussed. Many problems in distillation, extraction, absorption, and other operations illustrate the course.

Textbook: *Chemical Engineering*, Vols. I and II—Coulson and Richardson.

651. Chemical Plant Design. M. Wayman, D. MacKay.

Course 6, IV Year; 2 hrs. lectures and 6 hrs. laboratory per week, first term.

The lectures take a systems approach to the design of chemical plant, proceeding from the origin through major design considerations to technical and economic feasibility. Considerations applying to overseas situations, and the relationship of design to operation are included. In the plant design laboratory teams of students design and evaluate a particular plant.

Textbook: *Chemical Engineering Plant Design*—Vilbrandt and Dryden.

Reference book: *Chemical Engineering Cost Estimation*—Aries and Newton.

652. Chemical Engineering Laboratory. M. E. Charles and Staff in Chemical Engineering.

Courses 5c and 6, IV Year; 9 hrs. laboratory per week, first term.

A laboratory course to accompany subjects 631, 632, 650, and 651. Bench and pilot plant experiments are carried out to study a variety of unit operations such as fluidization, heat transfer, evaporation, filtration, distillation, extraction, and absorption. Modern control instruments are discussed and operated.

One laboratory report per week.

653. Applied Mathematics in Chemical Engineering. D. Basmadjian.
Course 6, IV Year; 3 hrs. laboratory per week, second term.
A problems course dealing with selected topics in dimensional, graphical and numerical methods, statistics and differential equations.
Reference books: *Mathematical Methods in Chemical Engineering*—Jenson and Jeffries.

654. Organic Chemistry. W. H. Rapson.
Course 6, IV Year; 2 hrs. lectures per week, second term.
The chemistry of natural and synthetic high-molecular-weight materials.

655. Chemical Engineering Thermodynamics and Kinetics. W. H. Burgess, W. F. Graydon.
Course 6, IV Year; 2 hrs. lectures per week, both terms.
The application of thermodynamics and kinetics to problems in the field of chemical engineering.

656. Public Speaking. Staff in Chemical Engineering.
Course 6, IV Year; 1 hr. per week, both terms.

660. Organic Chemistry. H. L. Williams.
Course 5c, IV Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.
A lecture course in organic chemistry, concluding with a section on the chemistry of high polymers.

661. Organic Chemistry Laboratory. Z. May.
Course 5c, IV Year; 6 hrs. laboratory per week, second term.
A laboratory course to accompany subject 660.

663. Instrumental Methods. S. Sandler.
Course 5c, IV Year; 2 hrs. lectures per week, second term.
The subject is designed to emphasize the science of chemical instrumentation. The principles, technique, and applications of gas-chromatographic, opticometric, electrometric, and mass-spectrometric methods of analysis are studied.

664. Process Dynamics. R. Luus.
Course 5c, IV Year; 2 hrs. lectures per week, both terms; 3 hrs. laboratory per week, second term.
Analysis and control of chemical engineering systems with emphasis on non-linear methods; phase plane; Liapunov's method; averaging technique.
Introduction to optimal control of processes; extraction train, distillation column, and chemical reactors.

665. Thermodynamics and Statistical Thermodynamics of Chemical Systems. R. W. Missen.
Course 5c, IV Year, 3 hrs. lectures per week, first term.
Development of the principles of chemical equilibrium and of

statistical mechanics; application to both non-reacting and reacting systems, with emphasis on behaviour of multicomponent mixtures and complex reactions, and the calculation of thermodynamic properties in the ideal-gas state.

Reference books: *The Principles of Chemical Equilibrium*, by K. G. Denbigh; *Introduction to Statistical Mechanics*, by G. S. Rushbrooke.

666. Chemical Engineering Design. M. E. Charles, M. Wayman, D. MacKay.

Course 5c, IV Year; 2 hrs. lectures and 6 hrs. laboratory per week, both terms.

Applications of heat transfer and fluid flow, mathematical modelling, and optimization in chemical engineering and chemical plant design. In the first term the laboratory is devoted to problems in these topics and in those of Subject 665. In the second term, simultation and optimization are carried out for a particular chemical plant.

Reference books: *Applied Mathematics in Chemical Engineering*—Mickley, Sherwood, and Reed. *Chemical Reactor Theory*—Denbigh. *Chemical Reaction Analysis*—Petersen.

667. Dynamics of Chemical Systems. I. H. Spinner.

Course 5c, IV Year; 3 hrs. lectures per week, second term.

Elements of chemical rate process, complex chemical system dynamics, chemical reactor stability. Application of analogue computers to the solution of problems in above topics.

670. Nuclear Engineering. D. G. Andrews, R. E. Jervis.

Course 5nt, IV Year; 2 hrs. lectures per week, both terms.

Nuclear engineering aspects of: nuclear constitution and properties including cross-section, energetics, radioactivity, production and use of radio-isotopes, neutrons, slowing down, "age" theory, diffusion of thermal neutrons, fission.

The age and two-group theories of the reactor core. Reflected reactors (elementary treatment). Reactor kinetics, control and instrumentation.

Applications of heat transfer, fluid flow and stress analysis to the reactor core.

The measurement and control of radiation. Exposure of humans to radiation. Shielding techniques.

Nuclear engineering applications of nuclear and radio-chemistry.

671. Nuclear Engineering Laboratory. D. G. Andrews, R. E. Jervis.

Course 5nt, IV Year; 3 hrs. laboratory per week, both terms.

A laboratory course to accompany subject 670.

Experiments are carried out with radiation sources and instruments, a sub-critical reactor, a reactor simulator, pulse height analyzers, fast neutrons generators and radioactive tracers.

DEPARTMENT OF ELECTRICAL ENGINEERING

700. Electricity. Staff in Electrical Engineering.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week, both terms; 6 three-hour laboratories during the session.

A basic course in electricity and magnetism including electric forces and fields, analysis of direct-current circuits, magnetic forces and fields, induction, and an introduction to the conductive, magnetic and dielectric properties of materials.

701. Electricity. Staff in Electrical Engineering.

Course 5, I Year; 2 hrs. lectures per week, both terms.

A basic course in electricity and magnetism that is similar to subject 700 but adapted to the needs of Course 5.

710. Circuit Theory I. A. J. Kravetz.

Course 7, II Year; 3 hrs. lectures per week both terms; 2 hrs. computation, alterate weeks, both terms.

The relation of lumped parameters to field concepts, their physical realization and their variation with frequency. The representation of simple systems by lumped parameter circuits.

The analysis of linear circuits in the steady state with either direct or alternating sources. Loop and nodal methods. The elements of the topography of circuits. Coupled circuits. Response of circuits to variable frequency.

The transient response of simple linear circuits to suddenly applied sources and its relation to the steady state.

Three-phase circuits, balanced and unbalanced. Other polyphase circuits.

General network theorems, rigorously derived, including the transformation theorems.

711. Electric and Magnetic Fields. S. D. T. Robertson.

Course 7, II Year; 2 hrs. lectures per week, both terms; 2 hrs. computation, alternate weeks, both terms.

Electric and magnetic fields, forces and energies associated with charged and current-carrying conductors embedded in dielectric and magnetic media. Particle dynamics in electric and magnetic fields. Time-varying fields in conductors and insulators. Development of Maxwell's equations and interpretation in static and dynamic situations.

712. Electrical Measurements. H. A. Courtice.

Course 7, II Year; 2 hrs. lectures per week, second term.

Measurement of electrical quantities such as charge, potential difference, current, magnetic flux, energy and power. Measurement of electrical properties such as dielectric constant, permeability and conductivity. Measurement of resistance, inductance and capacitance. Transducers for electrical measurement of

mechanical, thermal and other physical quantities. Measurement of alternating-current quantities in single-phase and polyphase systems. Accuracy of measurement, curve fitting and treatment of measured data.

713. Electrical Laboratory.

Course 7, II Year; 3 hrs. laboratory per week, both terms.

Appropriate laboratory experiments to accompany subjects 710, 711 and 712.

715. Electric Circuits. V. G. Smith.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Circuits as models for physical devices. Kirchhoff's laws. Transient response of circuits. Steady-state response of circuits with sinusoidal excitation. Network theorems. Topology and loop and nodal analysis of general circuits. Complex frequency analysis of circuits. Response of circuits to variable-frequency excitation. Analysis of polyphase circuits. Magnetically coupled circuits.

716. Electric Circuits Laboratory.

Course 5, II Year; 3 hrs. laboratory alternate weeks, both terms.

Laboratory exercises to accompany subject 715.

719. Electrical Engineering. R. S. Segsworth, H. O'Beirne.

Course 4, 6 and 8, II Year; 2 hrs. lectures per week, both terms.

Analysis of single-phase and three-phase circuits; principles of a-c and d-c machines; introduction to vacuum-tube and solid-state devices; basics of digital computation and analogue simulation; electronic measurements applied to industrial processes.

720. Electrical Laboratory.

Courses 4, 6 and 8, II Year; 3 hrs. laboratory per week, both terms.

Laboratory experiments and problems to accompany subject 719.

721. Programming and Numerical Methods. P. I. P. Boulton.

Course 7, II Year; 1 hr. per week lecture and problems, both terms.

FORTRAN and other programming methods. Numerical differentiation, integration and solution of differential equations. Computational algorithms.

722. Electrical Engineering I.

Course 3, II Year; 2 hrs. lectures per week, both terms.

Linear circuit analysis of d–c and a–c circuits both single and three phase leading to the steady state and transient solution of

electrical and mechanical circuits. Analogue computation is introduced. Emphasis is placed on the physics of transducers as well as basic measurement principles. Electrical machinery and energy conversion principles including solid state regulation and speed control techniques are presented.

723. Electrical Laboratory.

Course 3, II Year; 3 hrs. per week, first term; 1½ hrs. per week, second term.

Laboratory experiments to accompany Electrical Engineering I.

724. Electrical Engineering.

Course 1, II Year; 2 hrs. lectures per week, second term.

Single and three phase sinusoidal sources, series and parallel combinations of linear circuit elements, transformers, electrical energy transducers applied to power and measurement. Principle of semiconductor devices.

730. Physical Electronics. R. C. Cobbold.

Course 7, III Year; 2 hrs. lectures per week, both terms.

Introduction to solid-state physics and the theory of electron devices. Modelling and simple applications.

732. Applied Mathematics. P. P. Biringer.

Course 7, III Year; 2 hrs. lectures per week, both terms; 2 hrs. computation per week, both terms.

Vector analysis; functions of a complex variable, with applications to conformal mapping. Elementary probability theory and statistics.

733. Circuit Theory II. G. Sinclair.

Course 7, III Year; 3 hrs. lectures per week first term, 2 hrs. lectures per week, second term.

Fourier Integrals, Fourier and Laplace Transforms. Transients in lumped parameter circuits. Matrix techniques in network analysis. 2-ports. Transients in distributed parameter circuits. Steady-state analysis of transmission lines. Smith Chart.

734. Electric Machinery I. G. R. Slemon.

Course 7, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Processes for the electromechanical conversion of energy; properties of ferromagnetic materials; modelling of magnetic devices and systems; transformers and saturable reactors; commutator machines; an introduction to the control of electrical machines.

735. Electrical Laboratory.

Course 7, III Year; 3 hrs. laboratory per week, both terms.

Laboratory exercises to accompany subjects 733 and 734.

736. Electrical Problems and Seminar.

Course 7, III Year; 4 hrs. laboratory per week, both terms.

Problems associated with courses 730, 733, 734 and 737, worked out under staff supervision. To provide practice in technical public speaking, one hour per week in the first term is set aside to allow for a short talk by each student on a topic of his own choice.

737. Electronic Circuits.

Course 7, III Year; 2 hrs. lectures per week, second term.

Application of electron devices in amplification and signal processing.

738. Electronics Laboratory.

Courses 5a, 5cs, 5e, 5p and 7, III Year; Course 5m, IV Year; 3 hrs. laboratory per week, second term.

Laboratory experiments to accompany subjects 730, 737 and 739.

739. Physical Electronics. S. Dmitrevsky.

Courses 5a, 5cs, 5e, 5p, III Year; Course 5m, IV Year; 2 hrs. lectures per week, both terms.

A subject similar in content of that of 730 but adapted to the needs of Course 5.

740. Electronics. K. C. Smith.

Courses 5c, 5g, III Year; 2 hrs. lectures per week, both terms.

Qualitative treatment of the physical principles of electron devices; analysis of idealized and basic practical rectifying and power-modulating circuits; some applications to systems.

741. Electronics Laboratory.

Courses 5c, 5g, III Year; 3 hrs. laboratory alternate weeks, second term. Laboratory experiments to accompany subject 740.

742. Circuit Analysis. J. L. Yen.

Course 5cs, 5e, III Year; 2 hrs. lectures per week, both terms.

Advanced analytical methods are used to derive general network theorems and to discuss general network properties. Complex wave forms, filters and unbalanced polyphase networks are considered in detail.

743. Electronics.

Course 3, III Year; 2 hrs. lectures per week, first term.

Properties of vacuum tubes, gas tubes and semiconductors and their use as rectifiers and modulating devices. The use of circuit models in analysing the behaviour of electronic devices.

744. Electronics Laboratory.

Course 3, III Year; 3 hrs. laboratory alternate weeks, first term.

Laboratory experiments to accompany subject 743.

745. Energy Conversion Processes. S. D. T. Robertson.
Course 5e, IV Year; 2 lectures per week, both terms.
Energy conversion phenomena, magnetic materials, modelling and analysis of magnetic devices including transformers, commutator and polyphase machines, solid-state converters. Electromagnetic force and fluid interactions.

746. Energy Conversion Laboratory.
Course 5e, IV Year; 3 hrs. laboratory alternate weeks, both terms.
Investigations and projects related to subject 745.

747. Electric Machines. A. Straughen.
Course 3, III Year; 2 hrs. lectures per week, both terms.
Operating characteristics, control, and applications of direct-current and alternating-current machines, and transformers.

748. Electric Machines Laboratory.
Course 3, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.
Laboratory exercises and problems to accompany subject 747.

760. Electric Machines. W. Janischewskyj.
Course 4, IV Year; 2 hrs. lectures per week, first term.
Operating characteristics and applications of transformers and rotating electric machines.

761. Electric Machines Laboratory.
Course 4, IV Year; 3 hrs. laboratory per week, first term.
Laboratory exercises to accompany subject 760.

762. Electromagnetic Theory I. G. Sinclair.
Course 7, IV Year; 2 hrs. lectures per week, both terms; 2 hrs. computation alternate weeks, both terms.
Maxwell's equations, wave equations, retarded potentials, reciprocity theorem, plane waves.

763. Electric Machinery II. A. Straughen.
Course 7, IV Year; 2 hrs. lectures per week, first term.
The structure, field analysis and modelling of generalized polyphase machines; induction and synchronous machines; behaviour under unbalanced conditions; single-phase machines and alternating current control motors.

764. Electric Machines Laboratory.
Course 7, IV Year; 3 hrs. laboratory per week, first term.
Laboratory exercises to accompany subject 763.

765. Control Systems. H. W. Smith.
Course 7, IV Year; 2 hrs. lectures per week, both terms.
A study of the analysis and synthesis of linear feedback control systems by means of differential equations and the Laplace trans-

form. Topics covered include stability criteria, root-locus methods and compensation methods. An introductory study of non-linear systems is also made, including the use of describing-function and phase-plane methods of analysis.

766. System Dynamics. I. McCausland.

Course 5e, IV Year; 2 hrs. lectures per week, both terms.

A study of the dynamic behaviour of systems, using the techniques of state representation, Laplace and Z transforms, frequency-response and root-locus methods. Introduction to feedback control systems. Stability and compensation of linear and nonlinear control systems.

767. System Dynamics and Control Systems Laboratory.

Courses 5e and 7, IV Year; 3 hrs. laboratory alternate weeks, both terms.

Laboratory experiments to accompany subjects 765 and 766.

768. Electronic Circuits II. G. W. Dick.

Course 7, IV Year; 3 hrs. lectures per week, first term.

Application of electron devices in power amplification, detection, modulation, pulse shaping, etc.

769. Electronic Circuits Laboratory.

Courses 5a, 5cs, 5e, 5p and 7, IV Year; 3 hrs. laboratory per week, first term.

Experiments and problems to accompany subjects 768 and 778.

770. Communication Systems. G. R. Lang.

Course 7, IV Year; 3 hrs. lectures per week, second term.

An introduction to the analysis and design of systems for transmitting information.

771. Communications Laboratory.

Course 7, IV Year; 3 hrs. laboratory per week, second term.

Experiments and problems to accompany subject 770.

772. Network Theory.

Course 7, IV Year. 2 hrs. lecture per week, second term; 2 hrs. computation laboratory alternate weeks, second term.

Conventional filter design. Modern network theory and synthesis of filters.

774. Electric Machinery III. A. Straughen.

Course 7, IV Year; 2 hrs. lectures per week, second term.

Nonlinear power modulators, transient performance of induction and synchronous machines; reluctance, commutator and control machines.

775. Electric Machines Laboratory.

Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory exercises to accompany subject 774.

776. Electromagnetic Theory II.

Course 7, IV Year; 2 hrs. lectures per week, second term.

Basic field theory, Maxwell's equations, waves and modes in rectangular waveguides. Generation, coupling, transmission and detection of microwave energy. Resonant cavities, waveguide components and their uses.

777. Microwave Engineering Laboratory.

Course 7, IV Year; 3 hrs. laboratory alternate weeks, second term.

Laboratory experiments to accompany subject 776.

778. Electronic Circuits. G. W. Dick.

Courses 5a, 5cs, 5e, 5p, IV Year; 3 hrs. lectures per week, first term.

A course similar to subject 768 but adapted to the needs of Course 5.

779. Electric Power Systems. W. Janischewskyj.

Course 7, IV Year; 3 hrs. lectures per week, second term.

Engineering aspects of the economic generation, transmission and distribution of electrical energy in bulk and the control of power systems under normal and fault conditions.

780. Electric Power Systems Laboratory.

Course 7, IV Year; 3 hrs. laboratory exercises and problems per week, second term, to accompany subject 779.

781. Computer Logic and Design. E. S. Lee.

Courses 5cs, 7, IV Year; 2 hrs. lectures per week, first term, 1 hr. lecture per week, second term.

An introduction to the logical structure and electronic circuits of digital computers.

782. Information Systems I. G. Lang.

Courses 5cs, 5e, IV Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

The analysis and design of information systems and components, noise, information and signal theory.

783. Information Systems Laboratory.

Courses 5cs, 5e, IV Year; 3 hrs. laboratory per week, second term.

Experiments and problems to accompany subjects 782 and 786.

784. Quantum Electronics. S. Dmitrevsky.

Course 7, IV Year; 2 hrs. lectures per week, second term.

Schroedinger equation and simple applications. Quantum Statistics. Theory of susceptibility. Masers.

785. Quantum Electronics Problems.

Course 7, IV Year; 3 hrs. problems, alternate weeks, second term.

Problems associated with subject 784 worked out and discussed under staff supervision.

786. Information Systems II. G. W. Dick.

Courses 5cs, 5e, IV Year; 2 hrs. lectures and 3 hrs. laboratory per week, second term.

The study of digital information processing including the coding of data, and the design of logic circuits and switching systems.

787. Techniques of Optimization.

Course 5cs, IV Year; 2 hrs. lectures and 3 hrs. laboratory per week, both terms.

Linear and non-linear mathematical programming; dynamic programming; queueing theory; some problems in control theory; Monte Carlo methods. Applications will be drawn from Engineering practise.

788. Advanced Programming I.

Course 5cs, III Year; 3 hrs. lectures and 6 hrs. laboratory per week, first term.

Assembly language programming; the design and use of special programming languages such as list processors and algebraic manipulators.

789. Advanced Programming II.

Course 5cs, III Year; 3 hrs. lectures and 6 hrs. laboratory per week, second term.

The construction of compilers; system programming, including time-sharing systems.

790. Wave Theory. K. Balmain.

Courses 5e, 5p, IV Year; 2 hrs. lectures per week, first term; 3 hrs. lectures per week, second term.

Mechanical and electromagnetic waves in one dimension for transient and steady state conditions. Guided waves. Radiation. Interaction of waves with matter.

791. Wave Laboratory.

Course 5e, IV Year; 3 hrs. per week, second term. Supplementing course number 790.

792. Acoustics. V. L. Henderson.

Course 7, IV Year; 2 hrs. lectures per week and 3 hrs. laboratory alternate weeks, second term.

The properties of acoustical elements and their application in electrical sound systems.

794. Illumination. Miss M. G. Currie.

Course 7, IV Year; 2 hrs. lectures per week and 3 hrs. laboratory alternate weeks, second term.

Nature, measurement and production of light and related radiations.

Theory of human vision; consideration of environmental design requirements related to light and vision for optimum visual efficiency and comfort.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

801. Physical Chemistry. S. N. Flengas, J. M. Toguri.

Course 8, II Year; 1 hr. lecture per week, both terms.

A course on basic physico-chemical properties of matter with emphasis on kinetic theory of gases, phase relationships and transformations.

802. Chemistry of Metals. L. M. Pidgeon.

Courses 5m and 8, III Year; 2 hrs. lectures per week, first term.

A fundamental treatment of the metallurgical processes involved in the production of the important non-ferrous metals, including oxidation of sulphides in the liquid and solid states, reduction of oxides, matte-slag equilibrium, metal-slag equilibrium, and the distillation of metals.

803. Chemistry of Metals Laboratory. H. U. Ross.

Course 8, III Year; 3 hrs. laboratory per week, first term; 6 continuous hrs. laboratory per week, second term.

Experiments in materials processing, including roasting, smelting, leaching, refining, electrolysis to accompany Subjects 802 and 833. Eight laboratory reports per term.

804. Metallurgy. H. U. Ross.

Course 9, III Year; 2 hrs. lectures per week, second term.

An introductory course describing the theory and practice of metallurgical processes and operations.

805. Chemistry of Metals. L. M. Pidgeon, H. U. Ross.

Courses 5m and 8, IV Year; 2 hrs. lectures per week, both terms.

The extractive metallurgy of iron, steel, and the reactive metals.

806. Chemistry of Metals Laboratory. H. U. Ross.

Course 8, IV Year; 6 continuous hrs. laboratory per week, first term.

Experiments in the extraction and refining of metals and related processes to accompany Subject 805. Six laboratory reports per term.

808. Metallurgy. L. M. Pidgeon.

Course 9, IV Year; 1 hr. lecture per week, both terms.

The extractive metallurgy of the common metals, together with the calculations necessary to understand metallurgical processes.

810. Thermodynamics in Metallurgy. S. N. Flengas.

Course 8, III Year; 2 hrs. lectures per week, both terms.

A study of chemical equilibria at high temperatures in extractive metallurgy—slag metal reactions—classical theory of solutions—phase transformations—thermodynamic relationships in phase diagrams.

812. Metallurgical Problems Laboratory. S. N. Flengas, H. U. Ross.
Course 8, III Year; 4 hrs. laboratory per week, both terms.
Problems in chemistry, physical chemistry and thermodynamics as applied to metallurgical processes, and solid state reactions relating to Subjects 802 and 810.

813. Physical Chemistry of Materials. S. N. Flengas.
Course 8, IV Year; 2 hrs. lectures per week, both terms.
The physico-chemical principles of metallurgy—electro-chemical and thermodynamic properties of matter in the condensed states—thermodynamics of imperfections—quasi-chemical approach to the theory of solutions—properties of surfaces—kinetics of heterogeneous reactions—corrosion.

814. Metallurgical Problems Laboratory. S. N. Flengas.
Course 8, IV Year; 2 hrs. lectures per week, both terms.
Problems relating to subjects 805 and 813.

815. Physical Metallurgy. G. B. Craig, B. Ramaswami.
Course 1, II Year; 2 hrs. lectures per week, second term.
A course on the structure and mechanical properties of metals and alloys and on the influence of heat and mechanical treatment upon these properties. Reference is made particularly to steels and the more-important non-ferrous alloys. Welding of metals is also included.

816. Physics of Metals. B. Ramaswami.
Course 5c, IV Year; 1 hr. lecture per week, both terms.
A course on the physics of metals to include the structure of solids, defects in the solid state, diffusion, the effects of stress and temperature upon metals, and the relationship between structure and properties.

819. Physics of Metals. Staff in Metallurgy.
Courses 5e and 7, III Year; 2 hrs. lectures per week, second term.
A course on the physics of metals to include structure of solids, defect structures, diffusion, electron theory, phase transformations, and the effect of stress and temperature upon metals.

820. Physics of Metals Laboratory. Staff in Metallurgy.
Course 7, III Year; 1½ hrs. laboratory per week, second term.
Experiments are conducted to illustrate the essential features of Subject 819. These include the examination of metals by metallographic and X-ray diffraction techniques.

821. Physics of Metals. G. B. Craig, B. Ramaswami.
Courses 5m, 8, III Year; 2 hrs. lectures per week, both terms.
A discussion of the structure of solids with particular reference to X-ray methods of investigation; physical and mechanical properties of solids; and diffusion.

822. Physics of Metals Laboratory. Staff in Metallurgy.
Courses 5m and 8, III Year; 6 hrs. laboratory per week, first term; 3 hrs. laboratory per week, second term.
Practical work relating to Subject 821.

823. Physics of Metals. G. B. Craig, B. Ramaswami.
Courses 5m and 8, IV Year; 4 hrs. lectures per week, both terms.
Thermodynamics and kinetics of phase transformation in metals and alloys.

824. Physics of Metals Laboratory. G. B. Craig.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms.
Practical work relating to Subject 823.

826. Materials Science Seminar. Staff in Metallurgy.
Courses 5m and 8, IV Year; 3 hrs. laboratory per week, both terms.
Each student prepares and presents seminars on topics concerning chemistry and physics of materials.

827. Materials Science Laboratory. Staff in Metallurgy.
Course 5m, IV Year; 12 hrs. per week, both terms.
The design and execution of one or more experiments on a topic of current interest in the field of chemistry and physics of materials.

829. Chemistry of Metals Laboratory. H. U. Ross.
Course 5m, III Year; 3 hrs. per week, second term.
Experiments designed to illustrate the principles underlying the high temperature reactions which are encountered in the production and refining of metals.

830. Metallurgical Thermodynamics. S. N. Flengas.
Course 5m, III Year; 1 lecture per week, both terms.
Chemical equilibria at high temperatures in extractive metallurgy. Condensed states of matter—quasichemical approach to the theory of solutions—slag theories—metallic solutions—slag/metal equilibria—kinetics of metallurgical processes.

831. Metallurgical Thermodynamics Problems. S. N. Flengas.
Course 5m, III Year; 2 hrs. per week, both terms.
Problems relating to Subject 830.

832. Materials Science. Staff in Chemical Engineering, Civil Engineering, Electrical Engineering and Materials Science.
Course 8, II Year; Course 5m, III Year; 2 hrs. lectures per week, both terms.
A course on the structure and properties of plastics, glass, ceramics, semi-conductors, and concrete.

833. Materials Processing. H. U. Ross.

Course 8, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

The theory and practice of processing metallic and non-metallic materials, including the relevant aspects of mineralogy, surface chemistry, physical separation, calcining, roasting, sintering and leaching.

834. Materials Science. G. B. Craig.

Courses 3 and 4, II Year; 2 hrs. lectures per week, both terms and 3 hrs. laboratory per week, second term.

A discussion of the effects of microscopic and atomic structures on the electrical, chemical and mechanical properties of engineering materials. The topics covered will include atomic bondings, structures of ideal and real crystals, phase transformations and diffusion, chemical and mechanical properties, and oxidation and corrosion phenomena.

The laboratory experiments will include x-ray studies of crystal structure; measurement of resistivity and magnetism of selected solids; study of alloys through various phases and transformations; study of dislocation patterns, stress-strain relationships, stress-relaxation phenomena and fatigue phenomena; and study of oxidation and corrosion reactions.

INSTITUTE FOR AEROSPACE STUDIES

1028. Fluid Mechanics. H. S. Ribner.

Course 5a, III Year; 2 hrs. lectures per week, first term; 1 hr. lecture per week, second term.

Introductory concepts; mathematical theory of inviscid flow, incompressible and compressible; viscous flow and turbulence.

1029. Fluid Mechanics Laboratory. H. S. Ribner, B. Etkin, P. A. Sullivan.

Course 5a, III Year; 3 hrs. laboratory per week, first term; 3 hrs. laboratory alternate weeks, second term.

Problems and experiments related to subject 1028. Seven laboratory reports.

1030. Advanced Mechanics. S. J. Townsend.

Course 5, III Year; 2 hrs. lectures per week, both terms.

Mechanics of particles: fixed axes, rotating and moving axes, orbital dynamics, rockets. Mechanics of rigid bodies: fixed axes, body-attached axes, gyroscopes. Mechanics of linear systems: free and forced oscillations, coupled systems, waves on a string. Rayleigh's method. Lagrange's equations. Introduction to special relativity.

Reference books: *Introduction to Theoretical Physics*—Page. *Principles of Mechanics*—Synge and Griffith. *Dynamics*, Vols. I and II, Halfman.

1034. Mechanics of Structures. R. C. Tennyson.

Course 5a, III Year; 2 hrs. lectures per week, both terms.

Basic theorems and principles in the theory of structures (strain energy, virtual displacements, minimum total potential energy).

General theory of bending of beams (unsymmetrical bending, thin walled structures, shear flow in multiflanged beams, open and closed sections).

General theory of torsion (thin walled structures, multi-cell structures, shear centre).

Theory of elastic instability (buckling of slender elastic struts, flat and curved plates, shells).

Plane stress problems (Airy and Prandtl stress functions).

1035. Mechanics of Structures Laboratory. R. C. Tennyson.

Course 5a, III Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. per week, second term.

Problems and experiments relating to subject 1034. Five laboratory reports.

1040. Aerodynamics. B. Etkin.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Aerodynamics of flight: drag, propulsion, wing theory. Mechanics of flight: performance of aircraft, stability and control of aircraft.

Reference books: *Aerodynamics for Engineering Students*—Houghton and Brock. *Foundations of Aerodynamics*—Kuethe and Schetzer. *Flight Mechanics—1: Theory of Flight Paths*—A. Miele. *Dynamics of Flight—Stability and Control*—Etkin.

1041. Aerodynamics Laboratory. B. Etkin, P. C. Hughes.

Course 5a, IV Year; 3 hrs. laboratory alternate weeks, both terms.

Problems and experiments related to subject 1040.

Five laboratory reports.

1043. Engineering Design. G. K. Korbacher.

Course 5a, IV Year; 4½ hrs. laboratory per week, both terms.

A number of multidisciplinary engineering design projects are carried out by the student under the supervision of staff and of experienced design engineers from industry. Drawings and reports are prepared as required.

1044. Physics and Mechanics of Solids. G. K. Korbacher.

Course 5a, IV Year; 2 hrs. lectures per week, both terms.

Properties of solids, their dependence on atomic bonding, atomic and molecular structure. Structural imperfections and atom movements. Deformation and failure of metals. Multiphase materials and phase relationships. Modification of properties through microstructural changes. Environmental effects on service life. Physics of surface protection. Technology of non-destructive testing.

Reference books: *Elements of Materials Science*—Van Vlack. *Inelastic Behaviour of Engineering Materials and Structures*—Freudenthal.

1045. Physics and Mechanics of Solids Laboratory. G. K. Korbacher.
Course 5a, IV Year; 3 hrs. laboratory per week, both terms.
Problems and experiments related to subject 1044.
Six laboratory reports.

1046. Plasmadynamics. J. H. DeLeeuw, R. M. Measures.
Course 5a, IV Year; 2 hrs. lectures per week, both terms.
Maxwell's equations, concept of a plasma, motion of charged particles, introduction to confinement and stability, plasma equations of motion and conduction, simple examples of waves and flow problems in magnetogas dynamics, applications to propulsion and power generation, radiation from plasmas, diagnostics of plasmas.

1047. Plasma Diagnostics Laboratory. R. M. Measures, S. J. Townsend.
Course 5a, IV Year; 3 hrs. laboratory per week, both terms.
Probe and spectroscopical studies of a low pressure discharge and a magnetic shock tube plasma.
Three laboratory reports.

1048. Gasdynamics. P. A. Sullivan.
Course 5a, IV Year; 1 hr. lecture per week, first term; 2 hrs. lectures per week, second term.
Introductory thermodynamics of perfect and imperfect gases; equations of motion and their applications to nozzles, diffusers, shock tubes, and shock tunnels; expansion waves and normal and oblique shock waves in perfect and imperfect gases; shock and expansion wave interactions.
Reference books: *Elements of Gasdynamics*—Liepmann and Roshko. *Dynamics and Thermodynamics of Compressible Fluid Flow*—Shapiro. *Handbook of Supersonic Aerodynamics, Section 18, Shock Tubes*—Glass and Hall. *Introduction to Physical Gasdynamics*—Vincenti and Kruger.

1049. Gasdynamics Laboratory. P. A. Sullivan.
Course 5a, IV Year; 3 hrs. laboratory alternate weeks, first term; 3 hrs. laboratory per week, second term.
Problems and experiments based on subject 1048 are given to illustrate principles of gasdynamics and the measurement of physical quantities.
Six laboratory reports.

1050. Transport Phenomena. J. B. French.
Course 5a, IV Year; 1 hr. lecture per week, both terms.
A fundamental treatment of selected phenomena in fluid dynamics in which the transport of momentum, mass and energy are the key underlying processes, i.e. dynamics of viscous fluids; boundary layers; diffusion.
Reference book: *Transport Phenomena*—Bird, Stewart and Lightfoot.

DEPARTMENT OF PHILOSOPHY

2040. Philosophy of Science. F. F. Wilson, J. H. Woods.

Courses 1, 3, 4, 5, 6, 7, 8, and 9, IV Year; 2 hrs. lectures per week, first term.

The relation between Science and Philosophy; an examination of the presuppositions of science and its basic concepts; alternative accounts of the nature of the universe with their implications for social and moral behaviour.

DEPARTMENT OF ENGLISH

2110. English.

All courses, I Year; 2 hrs. lectures per week, both terms.

A course in essay writing and the reading of literary works.

Texts will include: Swift, *Gulliver's Travels* (Modern Library College); Twain, *Huckleberry Finn* (Facsimile Edn. or Walter Blair's Edn.); Fitzgerald, *The Great Gatsby* (Scribner); Shakespeare, *Antony and Cleopatra* (Arden); Jonson, *Volpone* (Yale); Miller, *Death of a Salesman* (Compass); one other novel, one other play, and a poetry anthology to be announced in September.

Students must complete satisfactorily all assignments, including class tests, given them by their instructor. It should be noted that the final mark for the year is the average of the term mark and the examination mark.

2140. English Literature.

All courses, IV Year; 1 hr. lecture per week, both terms.

A course in the drama, the novel and poetry based on the study of the following texts: Shakespeare, *Othello* (Ginn); Brecht, *Galileo* (Methuen); Williams, *Streetcar Named Desire* (Signet); Lawrence, *Sons and Lovers* (Viking); Fitzgerald, *The Great Gatsby* (Scribner); Golding, *Lord of the Flies* (Penguin); Oscar Williams, ed. *Immortal Poems of the English Language* (Washington Square); another play may be prescribed at the beginning of the session.

Students are expected to read the works named above during the summer preceding their entry into the Fourth Year. Term work will include assignments based on texts read during the summer, one substantial essay, and two class tests. Students will be graded on the basis of the term work.

DEPARTMENT OF HISTORY

2330. The History of Technology and Engineering. J. W. Abrams.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An historical treatment of the development of tools, techniques, and relevant skills from their inception processes will be considered along with the interplay with contemporary society.

Historical points of contact with theoretical and scientific thought will be examined. The accomplishments, influence, and role of the engineer will be traced from antiquity to current society.

2332. Europe and the Modern World, 1500–1950. J. Dent.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An introduction to the main currents of European history between 1500 and 1950, and of European relations with the extra-European world. The purpose of the course is not merely the accumulation of factual information, but also the attainment of some understanding of historical processes affecting the forms of political organization, economic activity, intellectual and social movements.

Textbook: E. R. Tannenbaum, *European Civilization Since The Middle Ages* (John Wiley).

DEPARTMENT OF MATHEMATICS

2410. Algebra and Analytic Geometry. Staff in Mathematics and Staff in Engineering.

Courses 1, 3, 4, 6, 7, 8, 9, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

Introduction to linear algebra with applications to three dimensional euclidean geometry. Matrix algebra and the solution of linear systems of equations. Determinants. Reduction of quadrics to standard form.

2411. Calculus. Staff in Mathematics and Staff in Engineering.

Courses 1, 3, 4, 6, 7, 8, 9, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

The theory of the derivative. Applications to curve sketching, rate problems and extremal problems. The definite integral. Volume and work calculations. Techniques of integration.

2415. Algebra and Geometry. B. Bernholtz, W. J. R. Crosby.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

Complex numbers and fields. Polynomials. Linear Algebra: linear equations, vector spaces and linear transformations. Coordinate Geometry: lines, planes and surfaces of the second degree.

2416. Calculus. L. T. Gardner, D. P. Wakfer.

Course 5, I Year; 2 hrs. lectures and 1½ hrs. problems per week, both terms.

An introduction to the theory and applications of differential and integral calculus.

Reference books: *Calculus*—Sherwood and Taylor. *Calculus*, Vol. I—Apostol.

2417. Introduction to Computing.

Course 5, I Year; 2 hrs. lectures and 2 hrs. laboratory per week, second term.

Introduction to algorithms and stored-program computers; Fortran programming; applications to numerical and non-numerical problems; simulations.

2420. Calculus. R. R. Burnside, N. A. Derzko, B. Karnopp, K. A. Selby, J. B. Wilker.

Courses 1, 3, 4, 6, 8 and 9, II Year; 2 hrs. lectures and 1 hr. problems per week, both terms.

Continuation of subject 2410. Partial differentiation, multiple integration, series and Taylor's theorem, complex numbers and hyperbolic functions, first order differential equations and higher order linear differential equations with constant coefficients.

2421. Calculus and Differential Equations. P. C. Greiner.

Course 7, II Year; 2 hrs. lectures per week, both terms. 2 hrs. computation per week, both terms.

The definite integral, expansion in series, ordinary differential equations, partial differentiation, multiple integration and an introduction to partial differential equations.

2422. Probability and Statistics.

Course 3, II Year; 2 hrs. lectures per week, second term.

Probability Concepts: Independent and conditional events, discrete and continuous frequency distributions, moments and generating functions.

Sampling: randomness, samples from populations, central limit theorem, transformation of variables, levels of significance. Tests of hypotheses.

2423. Probability and Statistics. L. Steinberg.

Courses 4 and 8, II Year; 2 hrs. lectures per week, both terms.

Frequency distributions and probability laws; binomial, Poisson, and normal distributions and the treatment of samples drawn from them; tests of significance and confidence limits; control charts; introduction to the analysis of variance; design of experiments; regression theory.

2424. Probability and Statistics Laboratory. L. Steinberg.

Courses 4 and 8, II Year; 2 hrs. laboratory per week, both terms.

Laboratory exercises associated with the material of the companion lecture subjects.

2425. Differential Calculus. C. Davis.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Ordinary and partial differentiation, differentials. Taylor's theorem for functions of one or more variables, maxima and minima, transformations, convergence and uniform convergence,

differential equations of the first order, linear differential equations with constant coefficients.

Reference books: *Advanced Calculus*—Sokolnikoff. *Advanced Calculus*—Taylor.

2426. Integral Calculus. W. J. Webber.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Methods of indefinite integration, definite integrals, multiple integrals, line and surface integrals, orthogonal functions.

Textbook: *Advanced Calculus*—Sokolnikoff.

2427. Probability and Statistics. R. Wormleighton.

Course 5, II Year; 2 hrs. lectures per week, both terms.

Definition of probability; binomial, Poisson, and normal distributions; frequency; sampling distributions. Examples of estimation, hypothesis testing, control charts, regression, and analysis of variance.

2428. Mathematical Problems, and Machine Computation. W. J. R. Crosby, C. Davis, W. J. Webber, R. Wormleighton.

Course 5, II Year; 3 hrs. problems per week, both terms.

A laboratory course: uses weekly problems based on the content of courses 2425, 2426, 2427 and provides an opportunity for informal discussion of topics presented in these courses. A portion of the time will be devoted to machine calculation.

2429. Numerical Methods. R. L. Johnston.

Course 5, II Year; 1 hr. lecture per week, both terms.

Non-linear equations, matrix calculations, quadrature, and ordinary differential equations.

2430. Probability and Statistics. I. MacNeill.

Course 4, III Year; 1 lecture per week, both terms.

A continuation of course 2423.

General regression theory; elements of the theory of sample surveys; an introduction to the theory of stochastic processes.

2431. Probability and Statistics Laboratory. I. MacNeill.

Course 4, III Year; 1½ hrs. per week, both terms.

Laboratory exercises based on the material of course 2430.

2432. Differential Equations. D. R. Breach, J. Thompson.

Courses 3, 4, 8, 9, III Year; 2 hrs. lectures per week, both terms.

First and second order ordinary differential equations, operational methods, variation of parameters, solution in series, Fourier series, Bessel and Legendre functions, the Laplace transform.

2433. Numerical Analysis. W. K. Hastings.

Course 4, III Year; 2 hrs. lectures per week, both terms.

Solution of algebraic equations, systems of linear equations, eigenvalue problems, interpolation, approximation theory, numerical integration, random numbers.

Reference texts: *An introduction to Numerical Mathematics*—E. L. Stiefel. *Methods in Numerical Analysis*—Kaj L. Nielsen. *Numerical Methods for Science and Engineering*—R. G. Stanton.

2434. Numerical Analysis Laboratory. N. Stewart.

Course 4, III Year; 3 hrs. laboratory per week, both terms.

Practice in the numerical analysis methods and techniques dealt with in the lecture subject. Practical problems, as well as problems of a fundamental mathematical nature, will be covered.

2437. Theory of Functions. M. P. Heble.

Course 5, III Year; 2 hrs. lectures per week, both terms.

Complex numbers, limits and series, analytic functions, Cauchy's theorem, Taylor and Laurent series, singularities and their significance, analytic continuation, contour integration, conformal mapping of one plane region on another.

Textbooks: *Functions of a Complex Variable*—Phillips. *Theory of Functions*—Copson. *Theory of Functions as Applied to Engineering Problems*—Rothe, Ollendorf, and Pohlhausen. *Introduction to Complex Variables and Applications*—Churchill.

2438. Differential Equations. D. K. Sen.

Course 5, III Year; 2 hrs. lectures per week, both terms.

First order equations solvable by quadratures, the linear equation of general order, operator methods, simultaneous linear equations, Sturm-Liouville systems, numerical methods.

Textbook: *Ordinary Differential Equations*—Kaplan.

2439. Mathematical Foundations of Computer Science.

Course 5cs, IV Year; 2 hrs. lectures per week, both terms.

Logic, recursive function theory, Turing machines and computability; theory of automata and formal languages; some aspects of graph theory.

2440. Numerical Solution of Partial Differential Equations.

Course 5cs, IV Year; 2 hrs. lectures per week, both terms.

The numerical solution of parabolic, hyperbolic and elliptic partial differential equations.

2445. Differential Equations of Mathematical Physics. G. F. D. Duff.

Courses 5a, 5cs, 5e, 5g, 5m, 5n, 5p, 5t, IV Year; 2 hrs. lectures per week, both terms.

The underlying theory and important particular equations, including eigenvalues and eigenfunctions, Fourier integrals, spherical and cylindrical harmonics, vibration of strings, membranes, and rods, sound waves, equation of heat conduction.

Textbook: *Partial Differential Equations of Mathematical Physics*—Webster.

DEPARTMENT OF PHYSICS

2501. The Structure and Properties of Matter. R. J. Balcombe, M. Fowler, J. Perz, B. P. Stoicheff.

Courses 1, 3, 4, 6, 7, 8 and 9, I Year; 2 hrs. lectures per week and 3 hrs. laboratory alternate weeks, both terms.

An introduction to the mechanical, electrical, magnetic, thermal and optical properties of matter in terms of atoms.

2511. Properties of Matter, Mechanics and Heat. D. G. Ivey.

Course 5, I Year; 3 hrs. lectures per week, both terms.

Textbook: *Elementary Classical Physics—Vol. 1*—Weidner and Sells.

2512. Physics Laboratory. D. G. Ivey and the staff in Physics.

Course 5, I Year; 3 hrs. laboratory per week, both terms; 1 hr. tutorial per week, both terms.

To accompany subject 2511.

2521. Physics. J. N. P. Hume.

Course 5, II Year; 3 hrs. lectures per week, both terms.

Fundamental theory of electricity and magnetism. Electromagnetic waves. Interference, diffraction and polarization of light waves. Elementary atomic physics.

2522. Physics Laboratory. J. N. P. Hume.

Course 5, II Year; 3 hrs. laboratory per week, both terms.

To accompany subject 2621.

2525. Physics—Heat and Optics. R. Richmond.

Course 1, II Year; 2 hrs. lectures and 1½ hrs. laboratory per week, first term.

Course 8, II Year; 2 hrs. lectures and 3 hrs. laboratory per week, first term.

Thermal expansion, capacity, conductivity; radiation laws. Reflection, refraction, dispersion. Lens systems and optical instruments. Polarising and phase microscopes, interference, diffraction, coherence, optical masers.

Textbooks: *Heat and Sound*—Sears. *Optics*—Sears.

2526. Physics II.

Course 7, II Year; 2 hrs. lectures and 3 hrs. Laboratory per week, second term.

Thermal expansion, capacity, conductivity and radiation including Planck's law, Wien's law, Stefan's law, Boltzmann distribution, thermal energy of particle, phonons. Basic concepts of reflection, refraction, dispersion and diffraction.

2531. Statistical Physics. J. C. Stryland.

Courses 5a, 5cs, 5e, 5g, 5nt, 5p, III Year; 2 hrs. lectures per week, second term.

The fundamental principles of thermodynamics, kinetic theory and statistical mechanics.

2532. Physics Laboratory. J. C. Stryland.

Courses 5a, 5e, 5nt, 5p, III Year; 3 hrs. laboratory per week, both terms. Course 5g, III Year; 6 hrs. laboratory per week, first term; 3 hrs. laboratory per week, second term.

To accompany subjects 2531, 2533 and 2534.

2533. Atomic Structure and Quantum Physics. A. E. Litherland.

Courses 5a, 5cs, 5e and 5p, III Year; 2 hrs. lectures per week, both terms.

Waves and particles; Schrodinger equation; harmonic oscillator, hydrogen atom, many-electron atoms; nuclear structure; radioactivity; interaction of radiation with matter.

2534. Physics of Solids and Fluids. R. List.

Courses 5e, 5g, 5m, 5p, III Year; 1 hr. lecture per week, both terms.

Elasticity, viscosity, equations of fluid motion, wave propagation, heat conduction, potential theory.

2535. Atomic and Nuclear Physics. N. R. Steenberg.

Course 5nt, III Year; 2 hrs. lectures per week, both terms.

Schrodinger equation, hydrogen atom, many electron atoms, radiactivity, nuclear structure, neutron physics, introduction to reactor theory, health physics.

2536. Physics of the Earth. G. D. Garland.

Course 5g, III Year; 2 hrs. lectures per week, both terms.

Seismology and the internal constitution of the earth; the gravitational field; the earth's magnetism and magnetic properties of rocks; radioactivity, geothermal heat and the age of the earth.

2537. Astronomy and Geophysics. P. R. Demarque, A. W. Brewer, J. T. Wilson.

Course 5g, III Year; 2 hrs. lectures per week, both terms.

A survey of astronomy—stars and stellar systems; an introduction to terrestrial and atmospheric Physics.

2541. Electromagnetic Radiation and Matter. H. L. Welsh, R. A. Armstrong.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Propagation of electromagnetic waves, polarization, diffraction, interference, dispersion, scattering. Absorption, spontaneous and stimulated emission, Einstein coefficients. Coherence, maser and laser action.

2542. Physics Laboratory. The Staff in Physics.

Course 5nt, IV Year; 6 hrs. laboratory per week, first term, and 3 hrs. per week, second term.

Course 5p, IV Year; 6 hrs. laboratory per week, both terms.

To accompany the lecture subjects 2541, 2544, and 2545.

2543. Molecular Physics and Statistical Mechanics. E. J. Allin and J. D. Poll.

Course 5p, IV Year; 2 hrs. lectures per week, both terms.

Quantum theory of rotation and vibration of molecules. Nuclear spins, symmetry, intensity rules, the hydrogen molecule, intermolecular forces. Boltzmann theory, transport equations, the Gibbs method, partition functions.

2544. Nuclear and High Energy Physics. K. G. McNeill, J. D. Prentice.

Courses 5nt, 5p, IV Year; 2 hrs. lectures per week, both terms.

Nuclear forces, alpha-decay, beta-decay. Excited states of nuclei. Nuclear models. Reaction theory. Mesons, anti-particles, hyperons.

2545. Quantum Mechanics. J. Van Kranendonk, L. E. H. Trainor.

Courses 5e, 5p, IV Year; 2 hrs. lectures per week, both terms.

Schrodinger equation, eigenvalues and eigenfunctions. Angular momentum, Pauli spin theory, identical particles. Perturbation theory, transition probabilities. Scattering theory.

2561. Theory and Application of Geophysical Methods. F. S. Grant.

Course 5g, IV Year; 2 hrs. lectures per week, both terms.

A course on the mathematical theory of magnetic, electrical, seismic and gravitational methods in applied geophysics.

2568. Exploration Geophysics. R. M. Farquhar, G. D. Garland.

Course 9, IV Year; 2 hrs. lectures per week, both terms.

An introduction to the physical principles underlying the important methods of geophysical prospecting. Particular attention is given to the seismic, gravitational, magnetic and electromagnetic methods.

2569. Geophysics. R. M. Farquhar.

Course 9, IV Year; 3 hrs. laboratory per week, both terms.

To accompany subject 2668.

2571. Atmospheric Physics. A. W. Brewer.

Course 5g, IV Year; 2 hrs. lectures per week, both terms.

2572. Solids within the Earth. J. C. Savage.

Course 5g, IV Year; 2 hrs. lectures per week, both terms.

The theory and experiments which are pertinent to the mechanical, thermal, and electrical properties of matter at the pressures and temperatures which obtain within the earth.

2573. Geophysics Laboratory. F. S. Grant, G. F. West.

Course 5g, IV Year; 6 hrs. per week, first term; 9 hrs. per week, second term.

A laboratory course stressing experimental and mathematical techniques applicable to the geophysical sciences.

DEPARTMENT OF CHEMISTRY

2622. Physical Chemistry. R. G. Barradas.

Courses 6 and 9, II Year; 2 hrs. lectures per week, both terms.

Chemical thermodynamics, phase rule and phase diagrams, electrochemistry, colloids and surface chemistry, kinetics.

2623. Chemistry. M. J. Dignam.

Course 7, II Year; 2 hrs. lectures per week, first term.

Inorganic chemistry, with emphasis on the fundamental particles, atomic structure, the nature of the chemical bond and general structural chemistry.

2624. Analytical Chemistry. J. A. Page.

Course 8, II Year; 1 hr. lecture and 3 hrs. laboratory per week, both terms.

Theory of quantitative separations and instrumental analysis. Aqueous solution chemistry.

2631. Atomic and Molecular Structure. J. P. Valleau.

Courses 5c, 5m, III Year; 2 hrs. lectures per week, both terms.

The application of wave mechanics to some problems of atomic and molecular structure.

DEPARTMENT OF POLITICAL ECONOMY

2720. Economics. D. M. Nowlan, J. P. Warner.

All courses, II Year; 2 hrs. lectures per week, both terms.

An introduction to the study of Economics with special reference to the problems of the Canadian economy.

Grades will be assigned on the basis of term work, essays and tests.

2730. Political Science. F. Peers, S. Taube.

All courses, III Year (elective); 2 hrs. lectures per week, both terms.

An introduction to political science, with special reference to the government of Canada.

Those students who obtain a satisfactory term mark will not be required to write the final examination.

Reference books: J. A. Corry and J. E. Hodgetts, *Democratic Government and Politics*; R. M. Dawson, *Government of Canada* (revised by Ward).

2734. Accounting. R. Paretz.

Course 4, III Year; 2 hrs. lectures per week, both terms.

Basic accounting principles and procedures, the preparation and interpretation of financial statements, cost accounting, and the use of accounting as a means of control.

DEPARTMENT OF PSYCHOLOGY

2840. Industrial Psychology. J. Sawatsky.

Course 4, IV Year; 2 hrs. lectures per week, second term.

A series of lectures and discussions on some of the human problems in industry, including the selection, classification and training of personnel, performance evaluation and the relationships between motivation and productivity.

DEPARTMENT OF GEOLOGY

2900. Geology for Engineers. W. H. Gross.

Course 1, II Year; 2 hrs. lectures per week, first term, 1 hr. second term; 3 hrs. laboratory per week, second term.

An introductory course in geology with special reference to engineering problems.

2901. X-ray Crystallography. E. W. Nuffield.

Courses 5m and 8, III Year; 2 hrs. laboratory per week, both terms.

A laboratory course in X-ray diffraction methods for students in Metallurgy and Material Science.

2902. Crystallography. E. W. Nuffield.

Course 5p, III Year; 1 hr. lecture per week, both terms.

Lattices, symmetry operations; classification of crystals into systems, point groups, Laue classes, space groups; crystal classes and forms; the diffraction of X-rays by crystals.

2920. Principles of Geology. The staff in Geology.

Course 9, II Year; course 5g, IV Year; 2 hrs. lectures, 2 hrs. laboratory per week, both terms.

Basic concepts of physical and historical geology.

2921. Mineralogy. The staff in Geology.

Course 9, II Year; 2 hrs. lectures, 3 hrs. laboratory per week, both terms.

Introductory crystallography; the principles of mineralogy; classification and description of the common minerals; introduction of the study of rocks.

2922. Optical Crystallography. P. A. Peach, D. H. Gorman.

Course 9, II Year; 2 hrs. laboratory per week, both terms.

Optical theory; the use of the polarizing microscope in the study of minerals.

2930. Petrology. P. A. Peach.

Course 9, III Year; 2 hrs. lectures, 2 hrs. laboratory per week, both terms.

The principles of petrology; the classification, description and interpretation of the sedimentary, igneous and metamorphic rocks. Microscopic petrography.

One laboratory report.

2931. Stratigraphy and Sedimentation. F. W. Beales, W. W. Moorhouse.

Course 9, III Year; 2 hrs. lectures, 2 hrs. laboratory per week, both terms.

Principles of stratigraphy with emphasis on tectonic and environmental interpretation of Precambrian and younger rocks. Problems of applied stratigraphy; petrographic interpretation.

2932. Structural Geology. W. M. Schwerdtner.

Course 9, III Year; 1 hr. lecture, 3 hrs. laboratory per week, both terms.

Development of structures in the sedimentary, igneous and metamorphic rocks of the earth's crust; laboratory study of methods employed in solving structural problems.

2933. Petroleum Geology and Ground Water. J. B. Currie, W. D. Baines.

Course 9, III Year; 2 hrs. lectures, 3 hrs. laboratory per week, both terms.

Occurrence; theory and application of hydrology to fluid flow in porous media; geological conditions of oil and gas entrapment in sedimentary basins; ground water movement and its relation to drainage basins. Laboratory exercises to accompany the lectures.

2934. Mineral Identification Laboratory. D. H. Gorman.

Course 9, III Year; 2 hrs. laboratory per week, both terms.

A continuation of the laboratory work in mineralogy of course 2921.

2935. Theory of Phase Equilibria. F. G. Smith.

Course 9, III Year; 2 hrs. lectures per week, both terms.

Thermodynamics of phase equilibria, phase diagrams, mineral systems.

2936. Geology Field Camp. The staff in Geology.

Course 9, III Year (14 days).

A field course in the Tweed area of Ontario complementing subjects 2921, 2930 and 2932.

2937. Geological Field Trips. The staff in Geology.

Course 9, III Year.

Field trips to places of geological interest during the fall to complement the subjects studied in the III Year.

2940. Mineral Deposits. W. H. Gross.

Course 9, IV Year; 2 hrs. lectures per week, both terms.

Theories of origin of mineral deposits; description of world's important mineral deposits.

2941. Mineral Deposits Laboratory.
Course 9, IV Year; 3 hrs. laboratory per week, both terms.

2942. Geological Data Analysis. F. G. Smith.
Course 9, IV Year; 2 hrs. lectures and 2 hrs. laboratory per week, both terms.
Applied mathematics, probability, statistics, computer programming.

2943. Exploration Geochemistry. G. M. Anderson.
Course 9, IV Year; 1 hr. lecture, 3 hrs. laboratory per week, both terms.
Use of trace element analysis techniques as an aid to discovery of ore deposits.

2944. Mineral Economics. W. H. Gross.
Course 9, IV Year; 2 hrs. lectures per week first term, 1 hr. lecture per week second term; 3 hours laboratory per week second term.
Economic principles pertaining to exploration, development and exploitation of mineral deposits.

2947. Geological Field Trips. The staff in Geology.
Course 9, IV Year.
Field trips to places of geological interest to complement the subjects studied in the IV Year.

INSTITUTE OF COMPUTER SCIENCE

3331. Engineering Data Processing. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 2 hrs. lectures per week, second term.
A course in programming and coding for the digital computer.

3332. Engineering Data Processing Laboratory. C. C. Gotlieb, R. W. P. Anderson.
Course 8, III Year; 3 hrs. laboratory per week, second term.
Practical work to accompany subject 3331.

3333. Computer Programming I. R. W. P. Anderson.
Course 4, II Year; 1 hr. lecture and 1½ hrs. laboratory per week, both terms.
Coding and programming for the digital computer; machine organization, machine language and symbolic compiler language (FORTRAN IV); number representation and conversion.
Laboratory exercises are drawn from the fields of engineering and applied science, as well as from those of data processing and elementary compilation.
Text: T. E. Hull, *Introduction to Computing*—Prentice-Hall.

3335. Computer Programming II. C. C. Gotleib and R. W. P. Anderson.
Course 4, III Year; 1 hour lecture and 1½ hour laboratory per week, both terms. (Commencing in the session 1967–68)

An extension of the Second Year subject Computer Programming I. More advanced discussion of general and specialized compiler languages and their application in business, engineering and other fields; simulation, data processing, and list processor languages; monte carlo methods; GPSS, SIMSCRIPT, COBOL, etc.

Laboratory problems are selected to complement the lecture material.

SPECIAL LECTURERS

3440. Engineering Law. W. O. Chris. Miller.

Courses 1, 3, 4, and 7, IV Year; 1 hr. lecture per week, first term.

A subject designed to co-ordinate the practice of engineering and law. Consideration is given to the characteristics, advantages and disadvantages of companies, partnerships and sole proprietorships, the promotion, organization and financing of companies, the duties of employees to employers, the duties and liabilities of engineers, statutes applicable to engineering works, professional engineering associations, construction contracts, workmen's compensation, trade unions and industrial disputes.

Textbook: *Engineering Law*—Laidlaw, Young, and Dick.

SCHOOL OF ARCHITECTURE

3540. Town and Regional Planning. D. Pinker, J. Paris.

Course 1B, IV Year; 1 hr. lecture and 3 hrs. practical work per week, both terms.

Problems of world urbanization; nature of the megalopolis, its guidance and control; urban functions and transportation; market analysis and research techniques; urban renewal.

Laboratory work includes exercises in survey research and analysis, subdivision layout, and urban analysis.

SECTION IX. GENERAL REGULATIONS; EXAMINATIONS

ATTENDANCE

1. Students proceeding to the degree are required to attend the courses of instruction and the examinations in all subjects prescribed. A student whose attendance at lectures or laboratories, or whose work is deemed by the Council of the Faculty to be unsatisfactory, may have his registration cancelled at any time.

2. Students must conform to all lecture room and laboratory regulations. Reports, briefs, theses and drawings become the property of the Council to dispose of as it may see fit. Drawings, briefs and field notes will not be accepted unless they have been made at the time and place provided in the time table.

TRANSFER OF COURSE

An undergraduate student who wishes to transfer from one course to another within the Faculty must petition to the Faculty Council and obtain its approval. Petitions for transfer of course must be submitted not later than 15 August.

PENALTIES FOR UNSATISFACTORY WORK

(*a*) In the case of unsatisfactory work of a very serious nature, the Faculty Council may recommend to the Senate that a student be debarred from the University.

(*b*) A student who on two occasions has failed to obtain promotion to a higher year will be refused further registration in the Faculty. A failure in engineering or in a related course at another institution will be counted in the same way as a failure in this Faculty.

(*c*) A student whose work is unsatisfactory may be suspended from attendance by the Council of the Faculty for a period of time not exceeding two years and/or until the satisfaction of other conditions as it may see fit.

(*d*) A student who withdraws after February 15, or who does not withdraw but does not write the annual examinations, will be regarded for the purposes of these regulations as having failed his year.

APPEALS

A student wishing to appeal to the Senate against a decision of the Council of the Faculty should consult the Secretary of the Faculty or the office of the University Registrar about the preparation and submission of his petition to the Secretary of the Senate.

ANNUAL EXAMINATIONS

1. Annual examinations will be held in April except as provided in paragraph 2 below.

2. Annual examinations will be held at the beginning of the second term in subjects completed during the first term.

3. Promotion from one year to another is made on the basis of the student's weighted average in the annual examinations and laboratory and other term work. Subjects will be weighted according to the number of hours devoted to them, the hours assigned to laboratory subjects being given one half the weight of those in lecture subjects.

Pass standing and promotion to the next higher year will be granted to students who obtain a weighted average of 60% or greater in the work of the year. (For special requirements in the first year of Engineering Science, see page 41.)

4. The student's work is graded in the following manner:

On Overall Average		*On Individual Subjects*	
Marks	Standing	Marks	Grade
75 — 100%	I Class (Honours)	75 — 100%	I
66 — 74%	II Class	66 — 74%	II
60 — 65%	III Class	60 — 65%	III
Below 60%	Failure	50— 59%	Pass
		Below 50%	Failure or BL

5. A student who obtains the passing average of 60% or greater in the work of the year but who has failed to pass one or more subjects will receive a standing of BL (below the line) in such subjects, and will be promoted to the next higher year.

6. Honour standing will be granted to students who pass in all written and laboratory subjects and who obtain a weighted average of 75% or greater in the work of the year.

7. Honour graduate standing will be granted to students who obtain honours in the final year and in any one previous year.

8. A student who fails in the work of any year will be permitted, unless otherwise ineligible, to register in a subsequent session for the purpose of repeating the year, subject to the following conditions:

(a) Only one such repetition will be allowed in the student's entire undergraduate course. A failure in enginering or in a related course at any other institution will be counted in the same way as a failure in this Faculty.

(b) During any such repetition, the full programme of prescribed instruction must be taken.

(c) Second, Third, or Fourth Year work may be repeated in the session immediately following that in which the failure occurs.

(d) A student who fails in the work for the First Year but who obtained an average of 50% or over will, provided he is otherwise eligible, be allowed to repeat the work of the year in the

following Session. All other students who fail in the work of the First Year must remain out for one Session before re-applying. If a student withdraws on or before 15th February he may re-apply for admission the following Session.

Any student re-applying for admission to the First Year must file a new application (as outlined in Paragraph 5, Section V) with the Registrar of the University.

9. A student should submit to Council immediately after its occurrence, evidence of any illness or mishap which occurs during the session; any petition for leniency on account of such incidents may be refused consideration if received after the third day following the last day of examinations.

10. A student will not be allowed to write any examinations if he has not paid all fees and dues for which he is liable at that time.

TERM EXAMINATIONS

Term examinations may be held in any subject and at any time at the discretion of the instructor, or by the order of the Council, and the results of such examination may be incorporated with those of the annual examinations in the same subjects.

EXTRA-CURRICULAR ACTIVITIES AND ACADEMIC CREDIT

It is in general desirable for students to engage to a reasonable extent in extra-curricular activities in order that they may not become too narrowly professional in interests and outlook, but it will be obvious that no academic credit or consideration can be given for such activities. Some offices in student organizations require quite large amounts of time for the proper performance of the duties connected with them, and it is therefore strongly recommended that students, particularly those whose academic records are not high, consult a senior member of Staff before allowing themselves to be nominated for such offices.

SECTION X. MEDALS, PRIZES, SCHOLARSHIPS, BURSARIES AND FELLOWSHIPS

Through the generosity of friends of the University, governments and commercial organizations, encouragement has been given to both undergraduate and graduate work in the various branches of engineering study by the establishment of the scholarships, prizes, bursaries and medals listed in the following pages.

ADMISSION SCHOLARSHIPS AND BURSARIES

Ontario Students:

Scholarships and bursaries available to students entering the First Year are listed on pages 125 and 126. For full details concerning these awards, applicants should consult the Calendar of Admission Awards, which is available at Secondary Schools or from the Office of Financial Aid, Simcoe Hall, University of Toronto. Applications, which must be made through the Principal of the Secondary School, close on May 1 annually.

Non-Ontario Students:

All non-Ontario students should apply to the Office of Financial Aid, Simcoe Hall, University of Toronto. A limited number of scholarships is reserved for students living outside the Province of Ontario, but as competition is keen such students must not count on receiving assistance but are advised rather to ensure that they have sufficient funds from their own government or from private sources to cover all probable expenses.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed on pages 126 to 131. Where it is necessary to make application for an award it is so stated in the description and particulars are given as to how the application should be made. In all other cases the award is made on the recommendation of the Faculty Council and no application is necessary.

GENERAL TERMS AND CONDITIONS

In order to be eligible for a medal, prize, scholarship, bursary, fellowship or other award granted solely upon standing obtained at an annual or special examination or upon an essay, or term work, or other academic rating, a candidate must obtain honours at such annual or special examination or upon such essay, term work, or other academic rating unless the terms of the award or medal specify that standing lower than honours may be accepted.

When an award or medal is granted upon standing obtained on part of the work of any academic year the candidate must obtain standing but need not obtain honours in the work of the academic year as a whole, provided he obtains honours in the part concerned, unless the terms of the award or medal specify otherwise.

No medal, prize, scholarship, bursary, fellowship or other award will be granted to a candidate who is conditioned in any subject at an annual examination or in Physical Education unless the terms of the award or medal specify otherwise.

A candidate will not be permitted to receive more than one award in a session unless the statute establishing each of the awards concerned or the Calendar specifies otherwise. Only one of those marked by an asterisk may be held in any one year. A candidate who would, but for this provision, have received more than one award may have his name so published in the class lists.

A candidate who has spent two sessions in any year of an undergraduate course is not eligible to compete for any award at the annual examinations of that year.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes other than awards for graduate study and research, will be paid in one instalment as soon as possible after the granting of the awards.

All other awards will be paid (i) if of the value of $100 or less, in one instalment on November 20 and (ii) if of the value of more than $100 in two equal instalments, the first on November 20 and the second on January 20, in the session following the granting of the awards. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

The Senate may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance upon lectures and laboratory classes for one year. Further postponement may be permitted on application.

Name	Value	Application required	Available only to a limited group or single course	See page
AVAILABLE TO STUDENTS ENTERING THE FIRST YEAR				
Alumni Association War Memorial Scholarships	$500	Yes	No	157
Alcan Scholarship	$500	Yes	No	132
J. P. Bickell Foundation Scholarships	$500	Yes	No	135
J. W. Billes Admission Scholarships	—	Yes	No	137
Dominion Magnesium Limited Bursary	$400	Yes	Yes	138

Name	Value	Application required	Available only to a limited group or single course	See page
Engineering Alumni Admission Bursaries	—	Yes	No	140
Engineering Alumni Admission Scholarships (7)	$1000	Yes	No	140
Grabill Admission Scholarship	$500	Yes	No	142
General Foods Scholarships	$500	Yes	No	141
Hagarty Memorial Scholarship	$60	Yes	Yes	142
The Murray Calder Hendry Scholarship	$500	Yes	No	143
International Nickel Scholarship	$300 + Fees	Yes	No	144
The Leonard Foundation Scholarships	—	Yes	Yes	145
J. Edgar McAllister Foundation	—	Yes	Yes	145
O.H.A. War Memorial Scholarship	$200	Yes	Yes	149
Ontario Chapter American Society for Metals Bursaries (2)	$400	Yes	Yes	133
Ontario Student Awards Programme	—	Yes	No	138
A.P.E.O. Admission Scholarship	$500	Yes	No	151
Regular Officer Training Plan	—	Yes	No	153
Helen E. Rogers Admission Scholarships	—	Yes	Yes	153
Simpson-Sears Limited (Northern Ontario) Scholarship	$100	Yes	Yes	154
Walter Sterling Admission Scholarships	—	Yes	No	155
U.T.S. Engineering Scholarship	$250	Yes	Yes	158
Wallberg Admission Scholarships (2)	$500	Yes	No	158
AVAILABLE TO STUDENTS COMPLETING THE FIRST YEAR				
Atkinson Incourse Bursaries	—	Yes	No.	134
Baptie Scholarship	$160	No	Yes	135
Canadian Bechtel Limited Bursaries	—	Yes	No	135
J. P. Bickell Foundation Scholarships	—	No	No	135
T. H. Bickle Prize	$30	No	Yes	136
Crocker Foundation Bursaries	—	Yes	No	138

Name	Value	Application required	Available only to a limited group or single course	See page
*John M. Empey Scholarship	$150	No	No	139
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	143
Inco Scholarship	—	Yes	Yes	144
Johnson's Wax Scholarship	$800	No	Yes	144
Kimberly-Clark Scholarship	$500	No	No	144
John Wolfe McColl Awards	—	Yes	No.	145
Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science	$95	No	Yes	146
MacLennan-LacLeod Memorial Prize	$25	No	No	147
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	148
Northern Electric Undergraduate Scholarship	$500	No	Yes	149
Ontario Student Awards Programme	—	Yes	No	138
Orenda Engines Scholarship	$500	No	Yes	143
Paulin Memorial Scholarship	$425	No	No	150
Procter and Gamble Bursary	—	Yes	No	150
*Professional Engineers Scholarship	$250	No	Yes	151
*Ransom Scholarship in Chemical Engineering	$150	No	Yes	151
Frederick W. Schumacher Scholarship	—	Yes	Yes	153
S. Ubukata Fund	—	Yes	Yes	157
University Naval Training Division Bursaries	$100	Yes	Yes	157
University of Toronto General Bursaries	—	Yes	No	158
*Wallberg Undergraduate Scholarships (2)	$500	No	No	158
AVAILABLE TO STUDENTS COMPLETING THE SECOND YEAR				
*Harvey Aggett Memorial Scholarship	$75	No	No	132
Ardagh Scholarship	$350	No	Yes	133
Association of Ontario Land Surveyors Scholarship	$500	Yes	Yes	134
Automotive Transport Association Bursary	—	Yes	No	134

Name	Value	Application required	Available only to a limited group or single course	See page
Babb Bursary Fund	—	Yes	Yes	134
Canadian Bechtel Limited Bursaries	$1200	Yes	No	135
J. P. Bickell Foundation Bursaries	—	Yes	Yes	136
J. P. Bickell Foundation Scholarships	—	No	Yes	135
T. H. Bickle Prize	$30	No	Yes	136
Carveth Metallurgical Ltd. Bursary	$500	Yes	Yes	137
Crocker Foundation Bursaries	—	Yes	No	138
Cyanamid of Canada Scholarship	$900	No	Yes	138
*John M. Empey Scholarship	$150	No	No	139
J. A. Findlay Scholarship	—	No	Yes	140
Hugh Gall Award	$140	Yes	No	141
Hydro-Electric Power Commission of Ontario Bursary	$500	Yes	No	143
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	143
Kimberly-Clark Scholarship	$500	No	No	144
The Lever Brothers Scholarships	$300	No	Yes	145
Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships	—	No	Yes	146
Charles Gordon Manning Prize	—	No	No	148
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	148
James L. Morris Memorial Prize	$125	No	Yes	149
Northern Electric Undergraduate Scholarship	$500	No	Yes	149
Ontario Student Awards Programme	—	Yes	No	138
Orenda Engines Scholarship	$500	No	Yes	143
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	155
William Storrie Memorial Scholarship	$100	No	Yes	156
*Professional Engineers Scholarship	$250	No	Yes	151
*Rhodes Scholarship	£1000	Yes	No	151
Scottish Rite Masons Bursary	$400	Yes	Yes	153

Name	Value	Application required	Available only to a limited group or single course	See page
Frederick W. Schumacher Scholarship	—	Yes	Yes	153
Edith Tyrrell Memorial Bursary	$600	Yes	Yes	156
University of Toronto General Bursaries	—	Yes	No	158
*Wallberg Undergraduate Scholarships	$500	No	No	158
*William R. Worthington Memorial Scholarship	$400	No	Yes	159
AVAILABLE TO STUDENTS COMPLETING THE THIRD YEAR				
Allied Chemical Canada Limited Scholarship	$950	No	Yes	133
American Institute of Industrial Engineers Scholarship	$150	No	Yes	133
Babb Bursary Fund	—	Yes	Yes	134
F. W. Baldwin Prize	$75	No	Yes	135
Canadian Bechtel Limited Bursaries	—	Yes	No	135
J. P. Bickell Foundation Bursaries	—	Yes	Yes	136
T. H. Bickle Prize	$30	No	Yes	136
*Boiler Inspection and Insurance Company Scholarship	$150	No	Yes	137
*Chevron Standard Limited Scholarship	$400	No	Yes	137
Chemical Institute of Canada Prize	$25	No	Yes	138
Crocker Foundation Bursaries	—	Yes	No	138
Dow Chemical of Canada Limited Award	$500	No	Yes	139
*John M. Empey Scholarship	$150	No	No	139
E.I.C. Prize	$50	No	Yes	140
Engineering Society Semi-Centennial Award	$75	No	No	140
J. A. Findlay Scholarship	—	No	Yes	140
James Franceschini Foundation Scholarship	$250	No	Yes	141
Chester B. Hamilton Scholarship	$500	No	Yes	142
I.B.M.—Thomas J. Watson Memorial Bursary Fund	—	Yes	No	143

Name	Value	Application required	Available only to a limited group or single course	See page
Cominco Scholarships	$800	Yes	Yes	138
*Jenkins Scholarship in Engineering	$200	No	No	144
The Lever Brothers Scholarship	$300	No	Yes	145
Loan Funds	—	Yes	No	159
J. A. D. McCurdy Prize	$75	No	Yes	146
Alexander MacLean Scholarship	$250	No	Yes	147
*Marsland Engineering Ltd. Scholarship	$250	No	Yes	148
Northern Electric Undergraduate Scholarship	$500	No	Yes	149
Ontario Student Awards Programme	—	Yes	No	138
Orenda Engines Scholarship	$500	No	Yes	143
*Professional Engineers Scholarship	$250	No	Yes	151
RCE Memorial Scholarship	$125	Yes	Yes	152
Murray F. Southcote Scholarship	$100	No	No	155
Frederick W. Schumacher Scholarship	—	Yes	Yes	153
Specification Writers Association Scholarship	$250	No	Yes	155
William Storrie Memorial Scholarship	$100	No	Yes	156
*Spruce Falls Power and Paper Company Scholarships	$400	No	No	155
Trane Company of Canada Limited Prize	$250	No	Yes	156
Edith Tyrrell Memorial Bursary	$600	Yes	Yes	156
University of Toronto General Bursaries	—	Yes	No	158
*Wallberg Undergraduate Scholarships	$500	No	No	158
AVAILABLE TO STUDENTS COMPLETING THE FOURTH YEAR				
Henry G. Acres Medal	—	No	Yes	132
American Society of Lubrication Engineers Prize	$75	No	Yes	133
J. P. Bickell Foundation Bursaries	—	Yes	Yes	136

Name	Value	Application required	Available only to a limited group or single course	See page
Babb Bursary Fund	—	Yes	No	138
Crocker Foundation Bursaries	$25	No	Yes	139
Electrical Manufacturing Co. Limited Prize	—	No	No	143
Hamilton Watch Award	—	Yes	No	159
Loan Funds	$500	Yes	Yes	148
Massey-Ferguson Ltd. Scholarships (2)	$300	Yes	Yes	150
Ontario Municipal Electric Association Bursary	—	Yes	No	138
Ontario Student Awards Programme	—	No	No	151
Professional Engineers Gold Medal	$50	No	Yes	151
J. E. Reid Memorial Prize	$200	No	Yes	156
William Storrie Memorial Scholarship	$100	No	No	154
Society of Automotive Engineers Prize	—	No	Yes	155
Society of Chemical Industry Merit Award	$200	No	Yes	154
"Second Mile Engineer" Award	—	Yes	No	158
University of Toronto General Bursaries	—	No	No	159
W. S. Wilson Medals				

NOTE—As the value of an endowed scholarship or prize is dependent on the actual income of the fund, it is possible that the value of certain scholarships and prizes at the time of payment may be less than the amount stated in the calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

HENRY G. ACRES MEDAL

The Henry G. Acres Medal is the gift of Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario in the period 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. Entering private practice in 1924, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which was vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

This medal is awarded annually to the student in the Fourth Year who is registered in the course in Civil, Mechanical, or Electrical Engineering, and who obtains the highest aggregate percentage at the annual examinations of the Third and Fourth Years, provided always that the student obtains honour standing in the examinations of the Fourth Year. Receipt of the medal does not preclude a student from being granted such other award as may in the opinion of the Council be appropriate.

HARVEY AGGETT MEMORIAL SCHOLARSHIP

This scholarship was donated by the late Mr. J. T. Aggett, of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual scholarship of the value of the annual income from the fund is to be awarded to a student of the Second Year in this Faculty who, obtaining honours and being one of the first three in his year by his standing at the annual examinations, has been adjudged highest of the three in general student activities and service in the University during his period of attendance. When regulations do not permit the winner to hold this scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a scholarship of higher value.

ALCAN SCHOLARSHIP

The Aluminum Company of Canada, Limited has made available an admission scholarship of a value of $500 to a student entering the First Year of an Honours Course in the Faculty of Arts and Science, the

Faculty of Applied Science and Engineering or in the Faculty of Law. The recipient must attain an academic standing satisfactory to the Committee of Award and demonstrate financial need. It is tenable in the later years provided First Class standing is maintained.

Application should be made to the Registrar of the University by May 1 on the regular Admission Scholarship Application form.

ALLIED CHEMICAL CANADA LIMITED SCHOLARSHIP

Allied Chemical Canada Limited has presented a scholarship of the value of tuition fees plus $250 to the student and a grant of $250 to the University, to be awarded to a student registered in the Fourth Year of the course in Chemical Engineering who has attained honour standing in the examinations of the Third Year. The recipient must be a Canadian or an American citizen and must not already be receiving other awards exceeding $250.

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS SCHOLARSHIP

The Southern Ontario Chapter, American Institute of Industrial Engineers offers a scholarship of $150 to a student entering the Fourth Year of the Industrial Engineering course who has consistently maintained a high academic standing, but not necessarily honour standing, during the previous three years.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS PRIZE

The Toronto Section of the American Society of Lubrication Engineers offers an annual prize of $75 to a student in the Fourth Year in Mechanical Engineering whose Thesis dealing with Lubrication is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory. The Prize is accompanied by a donation of $25 to the Department to purchase books on Lubrication.

ONTARIO CHAPTER, AMERICAN SOCIETY FOR METALS BURSARY

The Ontario Chapter, American Society for Metals provides two bursaries of a value of $400 each for students entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made for the Session 1958–59.

ARDAGH SCHOLARSHIP

The Ardagh Scholarship, of the annual value of the income from $7,500, has been provided in memory of his parents by Professor E. G. R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry in the

Faculty. It is awarded to the student who attain the highest standing in Honours at the annual examinations of the Second Year in the Course in Chemistry Engineering. The first award was made on the results of the annual examination of 1946.

ASSOCIATION OF ONTARIO LAND SURVEYORS SCHOLARSHIP

The Association has established a scholarship of $500 to be awarded to a student registered in the Surveying Option in the Third Year of the course in Civil Engineering at the Universty of Toronto or an equivalent course at any other University. This award will be granted by the Association at its annual meeting in February with due consideration being given to the following points:

(a) Through his activities, the student must show leadership ability and give promise of becoming a worthwhile influence in the affairs of the profession.
(b) While attention is given to scholastic ability, as evidenced by his academic standing, other factors also will be considered.
(c) Special consideration is to be given to financial need.

Students must apply to the Secretary of the Association of Ontario Land Surveyors, 8 King Street East, Toronto 1, Ontario, by letter prior to December 31 of the calendar year preceding that in which the award is to be granted.

ATKINSON IN-COURSE BURSARIES

Atkinson In-Course Bursaries, gift of the Atkinson Charitable Foundation, are awarded annually to students in the second or higher years of their courses. Applicants must have at least Second Class honours in the final examinations of the preceding year, demonstrate financial need and be a resident of the Province of Ontario.

Applications must be submitted to the Registrar of the University on or before December 1.

ATA TRUCKING INDUSTRY EDUCATIONAL FOUNDATION BURSARIES

The Automotive Transport Association of Ontario has established a bursary fund for students in the second or higher years of any undergraduate degree course who find themselves in serious financial need due to sudden, unexpected personal or family difficulties. Applications may be submitted to the University Registrar at any time during the session and the number and value of the bursaries will vary at the discretion of the Committee of Award.

THE BABB BURSARY FUND

Bursaries from this fund are available to students in any year of the Aeronautics Option in Engineering Science. Application is made through the Secretary of the Faculty.

THE F. W. BALDWIN PRIZE

The F. W. Baldwin Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44), in memory of Frederick Walker "Casey" Baldwin, a graduate of the School of Practical Science, who made a significant contribution in the field of Aeronautics in Canada; and who flew, on March 12, 1908, near Hammondsport, N.Y., the "Redwing," the first biplane built by the Aerial Experiment Association.

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in the annual examinations of Third Year in "structural subjects."

The first award was made on the results of the examinations of the Session 1953–54.

BAPTIE SCHOLARSHIP

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie, of Ottawa, and the Board of Governors has directed that a scholarship of one half the annual income shall be awarded annually to an engineering student on the record of the first Year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to $75.

The conditions of the award are as follows: That the scholarship be awarded to the student who, in the annual examinations of the First Year, enrolled in any one of the courses of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, or Metallurgy and Materials Science, obtains the highest aggregate percentage of marks in those subjects which are common to the First Year curricula of those courses. The first award was made on the results of the annual examinations of the Session 1925–26.

CANADIAN BECHTEL LIMITED BURSARIES

Canadian Bechtel Limited has established Bursaries in the Faculty of Applied Science and Engineering of an annual value of $1,200 to provide not more than four awards, each of a minimum value of $200 and a maximum value of $600. Two awards will be made to First Year students and one or two awards to students registered in any year of the Faculty. Applicants must demonstrate financial need and have academic standing satisfactory to the Faculty Council.

Application must be made to the Secretary of the Faculty on or before October 1.

J. P. BICKELL FOUNDATION SCHOLARSHIP

The Trustees of the J. P. Bickell Foundation have established scholarships, the number to be determined annually, in the Faculty of Applied Science and Engineering of a possible value of $1,500 payable $500 in the First Year and provided honours are obtained at the Annual Examinations, $500 in the Second and Third Years.

An applicant must obtain an average of at least 75% at the Ontario Grade XIII examinations immediately preceding his admission to the university and must undertake to enrol in Chemical Engineering, Metallurgy and Materials Science or Geological Engineering. Failing suitable candidates in the courses mentioned students registered in the Second Year Honour course in Geological Sciences, or Physics and Geology in the Faculty of Arts and Science who are academically qualified are eligible. These awards are of the same value and are tenable in the Second, Third and Fourth Years of the course, subject to maintenance of the required academic standing. If any scholarships are not awarded to those mentioned above, students registered in the Third Year of the Engineering Science course in the Faculty of Applied Science and Engineering and taking the Physical Metallurgy or the Geophysics option who are academically qualified are eligible. In this case the scholarship will have a value of $1,000, payable $500 in each of the Third and Fourth years, provided the required academic standing is maintained.

Applications from those entering First Year must be submitted to the Registrar of the University not later than May 1 on the regular admission scholarship application form. In other cases, applications are not required.

J. P. BICKELL FOUNDATION BURSARIES

The Trustees of the J. P. Bickell Foundation have established the J. P. Bickell Foundation Bursaries in the Faculty of Arts and the Faculty of Applied Science and Engineering. An applicant must be enrolled in Honour Science or in Mathematics, Physics and Chemistry in the Faculty of Arts, in which case he must undertake to study mining or geology in his higher years; or be enrolled in a higher year of an honour course in the geological or geophysical field in the Faculty of Arts; or be enrolled in Chemical Engineering, Mining Engineering, Metallurgy and Materials Science, or Geological Engineering in any year of the Faculty of Applied Science and Engineering. He must demonstrate financial need and have satisfactory academic standing.

Application must be made to the Registrar of the University on or before December 1.

THE T. H. BICKLE PRIZE

The T. H. Bickle Prize is the gift of Mr. and Mrs. E. W. Bickle in memory of their son, T. H. Bickle, an undergraduate of Trinity College and a member of the Senior Intercollegiate Swimming Team at the time of his death in 1937. The income from the endowment fund will be used to purchase a suitable prize to be awarded annually to a member of the Senior Intercollegiate Swimming Team of this University in any year, faculty or school. The Committee of Award shall consist of the Dean of the Faculty of Arts, the University Registrar, the Director of Athletics, and the Honorary Coach of Swimming. In awarding the Prize the Committee shall consider the character, scholarship, and general interests of the members of the team.

J. W. BILLES ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of J. W. Billes, open to students entering any degree course in the University. The value in each year is a minimum of $200 and a maximum of $1,500 dependent upon the financial need of the recipient. Applicants must satisfy the normal admission scholarship standards in their Grade XIII examinations to be eligible for an award and maintain first class honour standing to enjoy the scholarship in higher years. The number of scholarships awarded in any one year may be varied dependent upon the available funds.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

BOILER INSPECTION AND INSURANCE COMPANY SCHOLARSHIP

The Boiler Inspection and Insurance Company of Canada offers a scholarship in the Course in Mechanical Engineering of the value of $150 to the student who obtains highest honour standing in the regular examinations of the Third Year.

The successful candidate will be expected to proceed to his Fourth Year during the session next following the date of the award.

The amount of the award will be credited by the Chief Accountant to the fees of the Fourth Year of the successful candidate.

CHEVRON STANDARD LIMITED SCHOLARSHIP

Chevron Standard Limited has presented a scholarship of $400 to a student who achieves outstanding results in the annual examinations of the Third Year in the Geophysics Option in Engineering Science or in Geological Engineering in the Faculty of Applied Science and Engineering or achieves the highest standing at the annual examinations of the Third Year in Physics and Geology or Geological Sciences in the Faculty of Arts and Science.

The awards alternate annually between the Faculties of Applied Science and Engineering and Arts and Science and the First Award was made in the session 1960–61 in the Faculty of Applied Science and Engineering.

CARVETH METALLURGICAL LTD. BURSARY

Carveth Metallurgical Ltd. provides one or more bursaries to a total value of $500 for students entering the Third Year of Metallurgy and Materials Science. The award is made primarily on the basis of Second Year standing, but the need for financial assistance will also be taken into consideration.

The Bursary is available every third year, beginning in the Session 1961–62, and is to be awarded on the recommendation of the Department of Metallurgy and Materials Science. Applications should be made by letter to the Secretary of the Faculty of Applied Science not later than September 1 of the year in which the award is tenable.

CHEMICAL INSTITUTE OF CANADA PRIZE

The Chemical Institute of Canada offers a prize of the annual value of $25 in books to the student registered in the course in Chemical Engineering who, having obtained honours, receives the highest standing in the written and laboratory work of the Third Year.

The first award was made on the results of the final examinations of 1947.

COMINCO SCHOLARSHIPS

Two scholarships, of an annual value of $800 each, are provided by Cominco Limited and are offered to students in the Third Year of the courses in Chemical Engineering, Geological Engineering, Mechanical Engineering and Metallurgy and Materials Science in the Faculty of Applied Science and Engineering and to students in the Third Year of the courses in Chemistry and Geology in the Faculty of Arts and Science, the awards being made on the basis of the examination results of the Second Year. The scholarships may be renewed in the Fourth Year if satisfactory standing is maintained.

Application must be made to the Secretary of the Faculty on the regular in-course awards form not later than October 15.

CROCKER FOUNDATION BURSARIES

The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

CYANAMID OF CANADA SCHOLARSHIP

As a part of their programme to encourage technical development in Canada, Cyanamid of Canada Limited offers a scholarship of the value of $900 to a student entering the Third Year in Chemical Engineering or Industrial Engineering. The award is made to a student who has demonstrated high academic ability and outstanding scholarship in the work of the Second Year.

The first award at the University of Toronto was made in 1964.

DOMINION MAGNESIUM LIMITED BURSARY

Dominion Magnesium Limited provides a bursary of $400 for a student entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made in the Session 1958–59.

PROVINCE OF ONTARIO STUDENT AWARDS PROGRAMME

Awards under this programme will be made available to all Ontario students provided:

(i) they are in full-time attendance at a Canadian University (or other eligible institution).
(ii) they can demonstrate need of financial assistance.
(iii) they are either Canadian citizens or landed immigrants, have resided in Canada for at least twelve months and intend to reside permanently in Canada.

Each applicant's need will be assessed by the Department of University Affairs and the first $150 of the total established need will be paid in loan form. Of the balance 60% will be made available as a loan and 40% will be in the form of a bursary.

Application forms and further information are available at high schools for students entering the first year; students in attendance in the Faculty may obtain application forms from the Secretary.

DOW CHEMICAL OF CANADA LIMITED AWARD

Dow Chemical of Canada Limited have provided funds for an annual award of $500 to a student in Chemical Engineering in the Faculty of Applied Science and Engineering, and a grant-in-aid of $250 to be used in the winner's department to help defray the cost of equipment, supplies and administration.

The winner must:

(*a*) be registered in the Third Year in Chemical Engineering (the award will be made in the second term of the Third Year and will be paid to the winner during his Fourth Year);
(*b*) be in the upper half of the class;
(*c*) have demonstrated leadership in extra-curricular activities.

The award is not tenable with other awards in the gift of the Senate. Application is not required.

THE ELECTRICAL MANUFACTURING COMPANY LIMITED PRIZE

The Electrical Manufacturing Company Limited has established an annual Prize of $25 in the Faculty of Applied Science and Engineering.

The winner must:

(*a*) be registered in the Fourth Year in Electrical Engineering;
(*b*) obtain the highest aggregate percentage of marks at the final examinations in the subjects of the Fourth Year related to electrical distribution equipment, the subject to be determined by the Head of the Department of Electrical Engineering.

This Prize is tenable with other awards in the gift of the Senate.

THE JOHN M. EMPEY SCHOLARSHIPS

The John M. Empey Scholarship Fund was established under a bequest of $10,000 in the Will of the late John Morgan Empey, B.A.Sc., 1903. Three scholarships of equal value are provided from the income from the Fund. One of these scholarships is awarded in each of the First, Second, and Third Years on the results of the annual examinations, to a student who, taking honours, obtains the highest average percentage of marks in the written and laboratory subjects of his Year. The scholarships are open to any students registered in the Faculty. In case the winner of any one of these scholarships does not attend this Faculty

during the session next following the award, the right to the scholarship shall be forfeited and the award shall be made to another eligible student. The scholarships were awarded for the first time in 1944.

ENGINEERING ALUMNI ADMISSION BURSARIES

The Engineering Alumni Association has made a number of bursaries with a maximum value of $600 each available annually. Applicants must be residents of Ontario, register in the First Year of the Faculty of Applied Science and Engineering, and need financial assistance.

Applicants should consult their secondary school Principal for details. Further information may be obtained from the Chairman, Engineering Alumni Education Committee, Faculty of Applied Science and Engineering, University of Toronto.

ENGINEERING ALUMNI ADMISSION SCHOLARSHIPS

Seven scholarships, each of the value of $1000, are provided annually by the University of Toronto Engineering Alumni Association for students entering the first year of any course in the Faculty of Applied Science and Engineering. The awards are made on the basis of standing in the Ontario Grade XIII examinations.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

ENGINEERING INSTITUTE OF CANADA PRIZE

The Engineering Institute of Canada, having in view that one of its objects is to facilitate the acquirement and interchange of professional knowledge among its members, offers an annual prize of Fifty Dollars in this University, commencing 1931, to the student who, in his Third Year in any one of the six courses of Engineering, has proved himself most deserving as disclosed by the examination results of the year, in combination with his activities in the Engineering Society or with a local branch of another recognized engineering organization.

ENGINEERING SOCIETY SEMI-CENTENNIAL AWARD

The Engineering Society Semi-Centennial Award, to the value of $75 was established in 1931 to commemorate the semi-centennial of the founding of the "School". The award is made to a student entering the final year.

The selection is based upon the following qualifications, which bear equal weight in the selection of the winner: (*a*) General "School" activities. (*b*) Contributions to the Engineering Society Executive Committee. (*c*) Personality, and social and athletic activities. (*d*) Academic standing.

J. A. FINDLAY SCHOLARSHIPS

These scholarships were established through a legacy bequeathed by the late Miss Janet Findlay to the Department of Mechanical Engineering. Two scholarships are available, each of a value of one half of the income of the fund, to students in this Course, one for a student in the Third Year, the other for a student in the Fourth Year, but only if the

student continues his course in Mechanical Engineering. The selection will be made, on recommendation of the Head of the Department of Mechanical Engineering, from amongst the four students having the highest average percentage of marks at the annual examinations in the Second and Third Years respectively, but in making the award the student's general character, fitness for his profession, and financial circumstances will be given consideration. In case a student who has been awarded one of the scholarships changes his course or does not attend this University during the next following session, he shall forfeit his right to the scholarship and the award shall be made to another eligible student.

THE JAMES FRANCESCHINI FOUNDATION SCHOLARSHIP

This scholarship, of a value of $250, is awarded to the student in Civil Engineering who achieves the highest standing, with honours, at the annual examinations of the Third Year among those who do not hold an award of a value of $100 or more based on the results of these examinations.

HUGH GALL AWARD

The Hugh Gall Award, of the annual value of One Hundred and Forty Dollars, the gift of the Graduate Class of 1910, "to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career", was established in 1946 for a five year period and, through the generosity of Mrs. Hugh Gall extended for a further three year period. It is awarded to a student, who, having completed his First Year with a general average of at least 66% without conditions, has entered the Second Year, and is in special need of financial assistance in order to enable him to continue his course. It is desirable, but not necessary, that the recipient shall not already have been given any other scholastic award or scholarship applicable to the second year and he shall have shown indications of his firm intention and ability to follow successfully the profession of engineering.

Any second year student in the Faculty of Applied Science and Engineering is eligible to apply for this Bursary. Applications should be made to the Secretary of the Faculty not later than one month after the opening of the session.

GENERAL FOODS SCHOLARSHIP

This scholarship is awarded for general proficiency in the final secondary school year to a student entering the Faculty of Arts and Science, Applied Science and Engineering or Food Science, and is open for competition by any student resident in Canada. The value is $500 for each of four years, providing first class standing in maintained.

Ontario residents apply on the regular admission scholarship application form.

Students resident outside Ontario may obtain application forms from the Awards Department, Office of the Registrar, University of Toronto.

THE GRABILL ADMISSION SCHOLARSHIP

The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $500. It is awarded to the candidate who has standing amongst those with the highest average percentages in the subjects of Ontario Grade XIII required for admission to the Faculty of Applied Science and Engineering. Applicants are required to write the Problems paper but standing in this paper is used only as auxiliary information. The candidate must write the Grade XIII examinations at one sitting in the June preceding entry to the University after not more than one year's instruction in Grade XIII and must register in the Faculty of Applied Science and Engineering.

Application should be made to the Registrar of the University on the regular Admission Scholarship form by May 1.

THE REGINALD AND GALER HAGARTY SCHOLARSHIP

The Reginald and Galer Hagarty Scholarship, in memory of the dearly beloved sons of Lieutenant-Colonel E. W. Hagarty, B.A. 1883, M.A. 1908, and Charlotte Ellen Hagarty, his wife. Reginald Edward Walter Hagarty, B.A.Sc. (Honours) 1908, a graduate of the University in the Faculty of Applied Science and Engineering and at the time of his death on April 29, 1925, a Consulting Structural Engineer. Lieutenant Daniel Galer Hagarty, Princess Patricia's Canadian Light Infantry, a member of the class of 1916 in Applied Science, enlisted for the Great War at the end of his third year in June, 1915, killed in action in Sanctuary Wood, June 2, 1916. The scholarship is given in recognition of the fact that their father was an honour graduate in Classics of the University of Toronto. It is of the value of the annual interest on the capital sum of $2,000 and is to be awarded to a student who has been enrolled for his Grade XIII Year at Harbord Collegiate Institute and having obtained at least the required standing in each of the Grade XIII subjects necessary for admission to the Faculty, obtains the highest standing in English, a language other than English, and Mathematics, among the students who apply for the award from the Collegiate. He will be required to: (*a*) register in the Faculty of Applied Science and Engineering, (*b*) sign a declaration to the effect that he is willing to take up arms in the defence of Canada and the British Commonwealth should necessity arise as declared by the Parliament of Canada. The Scholarship was offered for award for the first time in 1945. Application should be made to the Registrar of the University on the regular admission scholarship application form not later than May 1.

CHESTER B. HAMILTON SCHOLARSHIP

Members of the family of the late Chester B. Hamilton, a graduate of this Faculty in 1906, have presented a Scholarship in his memory of the annual value of $500. It is held by a Fourth Year student in Mechanical Engineering who has achieved outstanding academic standing at the Annual Examinations of the Third Year.

The first award was made on the results of the examinations for the Session 1958–59.

HAMILTON WATCH AWARD

Hamilton Watch Company, Lancaster, Pa. presents a wrist watch, suitably engraved, to the Fourth Year student in the Faculty of Applied Science and Engineering who at the annual examinations attains Honour standing and who has achieved high aggregate marks during his four years in the social-humanistic subjects common to all courses.

HAWKER SIDDELEY CANADA LIMITED (ORENDA ENGINES DIVISION) SCHOLARSHIPS

Hawker Siddeley Canada Limited (Orenda Engines Division) have donated three scholarships each of a value of $500, awarded annually to students completing the First, Second and Third Years respectively in courses other than Geological Engineering. These scholarships are awarded to students with high academic standing and in cases of close competition, preference will be given to the student who indicates that he possesses initiative and leadership qualities and that he will be a credit to his profession after graduation.

This award may be held with other awards provided that the monetary value of the other awards does not exceed $100. The first award was made in the Session 1955–56.

THE MURRAY CALDER HENDRY SCHOLARSHIP

This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of the income from a capital sum of $10,000 and the recipient must:

(*a*) have attained an average of at least 75% on nine grade XIII examination papers, written at one sitting, required for admission to the Faculty and have the highest marks in the Problems paper;

(*b*) be entering the First Year of any course in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University by May 1 on the regular University Admission Scholarship Application form.

The first award was made in the Session 1962–63.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO BURSARY

The Hydro-Electric Power Commission of Ontario has provided a bursary of the value of $500, which may be awarded to a student entering the second year of the courses in Mathematics and Physics or Commerce and Finance in the Faculty of Arts and Science, or any course in the Faculty of Applied Science and Engineering. Application should be made on the regular in-course bursary form not later than December 1.

IBM—THOMAS J. WATSON MEMORIAL BURSARY FUND

International Business Machines Company Limited has made available one or more bursaries of a total annual value of $1,000 to students registered in any year of a full time course in the university who have standing satisfactory to the Committee of Award and demonstrate financial need.

Application should be made to the Registrar of the University by October 31.

INTERNATIONAL NICKEL SCHOLARSHIPS

The International Nickel Company of Canada, Limited, annually provides one scholarship to students entering the University of Toronto for studies in Engineering, Geology, Geophysics, Mathematics, Physics or Chemistry with preference being given to Metallurgical Engineering. Awards are renewable for three additional academic years provided satisfactory standing is maintained.

Valued at $1,200 annually, each scholarship provides for tuition and fees, a $300 living allowance, and a grant of up to $500 to the University as a cost-of-education supplement.

To be eligible for consideration the applicant must obtain an average of 75% or over in the Ontario Grade XIII subjects required for admission to his course and demonstrate financial need.

Application must be made to the Registrar of the University by May 1 on the regular scholarship application form.

JENKINS SCHOLARSHIP

The Jenkins Scholarship, presented by Jenkins Bros., Limited, Montreal, first awarded in 1925, has been donated to continue indefinitely.

This Annual Scholarship, of the value of $200, is awarded to the student of the Third Year registered in any course of the Faculty who has the highest aggregate of percentages for the First, Second, and Third Years.

JOHNSON'S WAX SCHOLARSHIP

S. C. Johnson and Son Limited, Brantford, Ontario, have established a Scholarship of an annual value of $800 in each of the Second, Third and Fourth Years or a total possible value of $2,400.

The recipient must:

(*a*) be registered in Chemical Engineering in the years in which the Scholarship is awarded and held;

(*b*) in the opinion of the Council be the most promising and deserving member of the class, obtaining Honours in the final examinations of the First Year;

(*c*) in his Second and Third Years, maintain academic standing satisfactory to the Council, not necessarily Honours, for the continued enjoyment of the Scholarship.

In its discretion the Council may recommend the award of any portion of the Scholarship, lost by the original recipient by failure to maintain satisfactory academic standing, to another student of the year(s) in which the Scholarship would otherwise have been enjoyed.

The first award was made on the results of the annual examinations written in April 1954. It is not tenable with any other Scholarship.

KIMBERLY-CLARK CORPORATION OF CANADA LIMITED SCHOLARSHIPS

Kimberly-Clark Corporation of Canada Limited has presented two scholarships of a value of $500 each and each scholarship is acompanied by a grant of $100 to the general funds of the University. One

scholarship is awarded to an outstanding student of the First Year and one to an outstanding student of the Second Year as indicated by the examination results of their respective years. Students in all courses of the First and Second Years are eligible.

The First awards were made on the results of the annual examinations for 1957–58.

THE LEONARD FOUNDATION SCHOLARSHIPS

Leonard Foundation Scholarships are awarded each year to selected students in Universities and Colleges across Canada, including the University of Toronto. The Trust Deed states: "Preference in the selection of students for scholarships shall be given to the sons and daughters respectively of the following: (*a*) clergymen, (*b*) school teachers, (*c*) officers, non-commissioned officers and men, whether active or retired, who have served in Her Majesty's military, naval or air forces, (*d*) graduates of the Royal Military College of Canada, (*e*) members of the Engineering Institute of Canada, (*f*) members of the Mining and Metallurgical Institute of Canada."

All applicants must be nominated by a member of the General Committee. The latest date for the receiving of applications is March 31, for the following academic year. Further information regarding the procedure to be followed in applying for these scholarships may be obtained by writing to Dr. W. E. Taylor, Honorary Secretary, The Leonard Foundation, c/o Toronto General Trusts Corporation, 253 Bay Street, Toronto.

THE LEVER BROTHERS SCHOLARSHIPS

Lever Brothers Limited have established two Scholarships of $300 each in the Department of Chemical Engineering. The Scholarships will be awarded to a student of the Second Year and to a student of the Third Year in Chemical Engineering to be held in the Third and Fourth Years respectively. The award is based on outstanding scholarship at the annual examinations.

The first awards were based on the annual examinations of 1957.

THE J. EDGAR MC ALLISTER FOUNDATION

Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1891, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mechanical, Chemical, Electrical and Metallurgy and Materials Science. Inquiries should be made in the Faculty Office.

THE JOHN WOLFE MC COLL MEMORIAL AWARDS

These six awards, two of which are open to students in the Faculty of Applied Science and Engineering, are the gift of the estate of the late John Wolfe McColl. The awards have a minimum value of $250 and a

maximum of $750. Applicants must have obtained First Class Honours at the final examinations of the preceding year, whether Ontario Grade XIII or at the University of Toronto, demonstrate financial need and be enrolled or undertake to enrol in either Engineering Science or Chemical Engineering. Students seeking first admission to the University must submit applications for an award to the Registrar of the University on or before May 1. Students in the University must submit applications for an award to the Registrar of the University on or before October 15.

THE J. A. D. MC CURDY PRIZE

The J. A. D. McCurdy Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44) in honour of John Alexander Douglas McCurdy, a graduate of the School of Practical Science, who "made the first flight in Canada on February 23, 1909, with a heavier-than-air machine."

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in annual examinations of the Third Year in the subjects related to Aerodynamics.

The first award was made on the results of the examinations of the Session 1953–54.

THE GARNET W. MC KEE-LACHLAN GILCHRIST SCHOLARSHIP IN ENGINEERING SCIENCE

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a Scholarship in the First Year of the Course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual examinations of the First Year in the Course in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in honours in the Course. In order to receive payment the winner must register in the Second Year of the Course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations of 1947.

THE GARNET W. MC KEE-LACHLAN GILCHRIST GEOPHYSICS SCHOLARSHIPS

Financial assistance was received by Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, from certain organizations and individuals to help him in the prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. To this fund have been added additional amounts received from the estate of the late Garnet W. McKee and from the

Hollinger Consolidated Gold Mines Ltd. They are awarded by the Senate, on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the Annual Examinations of 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $190 is awarded to the student in the Second Year in the Course of Engineering Science who obtains the highest aggregate standing at the examinations of the First and Second Years in the Course, provided always that the student obtains honour standing at the examinations of the Second Year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $140 is awarded to the student in the Second Year in the Course of Engineering Science who, of those students who elect to proceed in the Third Year in the Geophysics Option of the Course, obtains the highest aggregate standing at the examinations of the First and Second Years, provided always that the student obtains honour standing at the examinations of the Second Year, and excluding always the student to whom the First Lachlan Gilchrist Geophysics Scholarship has been awarded.

If in any year there is no student who has fulfilled the conditions as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second Year in the Course in Engineering Science who obtains the second highest aggregate standing at the examinations of the First and Second Years of that Course, provided always that such student obtains honour standing in the examinations of the Second Year.

THE ALEXANDER MAC LEAN SCHOLARSHIP

This scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A. (1908) who retired in 1954. The scholarship, of the value of $250, is awarded to a student in the Third Year of Geological Sciences, Faculty of Arts, or in the Third Year of Geological Engineering, Faculty of Applied Science and Engineering, who, obtaining not less than 75% in the work of the year, obtains the highest standing in the geological subjects common to the two courses.

The first award was made in 1955.

MAC LENNAN-MAC LEOD MEMORIAL PRIZE

The Graduating Class of 1910 has donated an annual prize, known as "The MacLennan-MacLeod Memorial Prize", in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug. MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of $25, is awarded to the First Year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the

annual written examinations; or, in the event of more than one student obtaining equally high rank in Calculus, the award is made to the one of these who also has the highest standing in some other subject common to the competitors, such as Analytical Geometry, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in a subsequent year.

CHARLES GORDON MANNING PRIZE

The Charles Gordon Manning Prize was established by a bequest under the Will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the Prize.

The recipient must be enrolled in the Second Year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations specified for the award of that Scholarship, namely, obtaining honours in his final examinations and being one of the first three in his year by his standing at those examinations relative to the pass requirements in his Department and being "adjudged highest of the three in general student activities and service in the University during his period of attendance."

The first award was made on the results of the Annual Examinations of 1954.

MARSLAND ENGINEERING LIMITED SCHOLARSHIP

The Marsland Engineering Limited Scholarship, the gift of Marsland Engineering Limited, has a value of $250. It is awarded to the student who, having been granted a Dominion-Provincial Student Aid Bursary in his First Year, is registered in Mechanical or Electrical Engineering and obtains the highest average percentage of marks, with honours, at the annual examination of the First, Second or Third Years in the session in which the award is made.

The first award was made at the annual examinations of 1954.

MASSEY-FERGUSON LIMITED SCHOLARSHIPS

Massey-Ferguson Limited has established two scholarships each of an annual value of $250, to be awarded on the recommendation of the Council of the Faculty of Applied Science and Engineering to students registered in the Fourth Year of the Courses in Mechanical Engineering or Industrial Engineering. In making the award academic achievement, financial need, extra-curricular activities and such other factors as may be deemed appropriate will be taken into consideration.

Application should be made to the Secretary of the Faculty not later than October 15.

JAMES L. MORRIS MEMORIAL PRIZE

The James L. Morris Memorial Prize is the gift of Mrs. J. H. Craig and Mr. J. R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career. Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For 43 years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal, power and bridge work.

This Prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second Year in the Course in Civil Engineering who obtains the highest aggregate percentage at the annual examinations of the First and Second Years of the course, provided always that the student obtains honour standing at the Examinations of the Second Year.

NORTHERN ELECTRIC UNDERGRADUATE SCHOLARSHIP

The Northern Electric Company Limited have established a Scholarship in the Faculty of Applied Science and Engineering and the Faculty of Arts of an annual value of $500. In this Faculty the scholar must be registered in the First, Second or Third Year of Electrical Engineering, Mechanical Engineering, Engineering Science or Industrial Engineering. He must also (*a*) be a Canadian citizen or landed immigrant and (*b*) have a minimum of 75% or its equivalent in the previous annual examinations, in this or another recognized University. This scholarship is not tenable with other awards from commercial sources, or with awards stipulating subsequent employment as a condition (e.g. R.O.T.P.).

The award is made alternately in the two faculties, the first in the Faculty of Arts in 1959 and in the Faculty of Applied Science and Engineering in 1960 and in a similar manner thereafter. Application is not required.

THE ONTARIO HOCKEY ASSOCIATION WAR MEMORIAL SCHOLARSHIP

The Ontario Hockey Association War Memorial Scholarship, the gift of the Ontario Hockey Association, is to be awarded annually at the Grade XIII examination to an applicant whose father served overseas with the Canadian Forces in World War I.

The value of this scholarship is $100 in cash, with an allowance of the same amount on the tuition fee for each session.

In determining the award of the scholarship, the academic qualifications of the candidate shall be first taken into account, provided always that no candidate shall be eligible for an award who has not met all the conditions required by the University of candidates for admission scholarships generally; but, *cæteris paribus*, the award shall be made to a student who is in proved need of assistance.

The award shall be made by the Senate of the University upon the report of a committee to be appointed by the Senate, upon which committee there shall be always one member of the Staff of the University who shall be deemed to be the representative of the Association.

Application should be made to the Registrar of the University on the regular scholarship application form not later than May 1.

ONTARIO MUNICIPAL ELECTRIC ASSOCIATION BURSARY

District No. 4 of the Ontario Municipal Electric Association has provided a Bursary of $300 in the Faculty of Applied Science and Engineering.

An applicant for the Bursary must:

(*a*) be registered in the Fourth Year, Electrical Engineering;

(*b*) have good academic standing;

(*c*) be in need of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

PAULIN MEMORIAL SCHOLARSHIP

The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a graduate of this Faculty in 1907, was established in memory of his brother, John Cameron Paulin, a student of this Faculty, who was fatally injured in 1906 during a football practice. The scholarship, which has the value of the income from a capital fund of $10,000, approximately $425 annually, is awarded to a student who obtains high standing in the work of the first year in the Faculty of Applied Science and Engineering.

PROCTER AND GAMBLE BURSARY PLAN

Procter and Gamble Bursaries, the gift of the Procter and Gamble Company of Canada, are awarded annually to students in all years. Applicants must have at least Second Class Honours or better in the final examinations of the preceding year and demonstrate financial need. Applications must be submitted to the Registrar of the University on or before December 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO ADMISSION SCHOLARSHIP

The Association of Professional Engineers of the Province of Ontario has established an Admission Scholarship in Engineering of the value of $500. It is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more

than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Application must be made to the Registrar before May 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO SCHOLARSHIPS

The Association of Professional Engineers of the Province of Ontario offers Scholarships of a value of $250 in each of the First, Second and Third Years in the Faculty of Applied Science and Engineering in any course, to the students who, taking Honours, obtain the highest standing in the work of their respective years.

These scholarships will not be awarded to students who hold other scholarships.

PROFESSIONAL ENGINEERS GOLD MEDAL

The Association of Professional Engineers of the Province of Ontario has established in the Faculty of Applied Science and Engineering an award in the form of a gold medal accompanied by a gift of technical books of an approximate value of $50. The award will be made to the student of the final undergraduate year in any course who, taking honours, obtains the highest weighted average percentage in the practical work and written examinations of the year.

RANSOM SCHOLARSHIP IN CHEMICAL ENGINEERING

The Ransom Scholarship in Chemical Engineering is presented by A. C. Ransom, Esq., of Toronto, for the purpose of encouraging and giving financial assistance to students who choose the field of Chemical Engineering. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount such as will be derived from the income of this sum. The first award was made on the results of the annual examinations of 1938.

The scholarship will be awarded annually to the student registered in the Course in Chemical Engineering who obtains the highest aggregate percentage of marks in the examinations of the First Year. The scholarship will be paid to the winner only if he proceeds to take his Second Year in the Course in Chemical Engineering in the University of Toronto.

J. E. REID MEMORIAL PRIZE

This prize, established in 1967 in memory of the late Professor J. E. Reid, is awarded to the student in the Fourth Year of the course in Electrical Engineering who, graduating with honours, achieves the highest aggregate marks in the Fourth Year examinations in the subjects pertaining to electronic communication.

THE RHODES SCHOLARSHIP

The Rhodes Trustees offer for award in the Province of Ontario two out of ten of the Rhodes Scholarships for Canadians, each of the value of £1,000 and tenable at Oxford University for a period of two years; in certain cases, a third year may be authorized.

Each candidate must be a British subject with at least five years domicile in Canada and unmarried; he must have passed his nineteenth but not his twenty-fifth birthday on October 1 of the year *for* which he is elected; he must have completed the first year and have entered upon the second year of his course at a Canadian university at the time of application.

A candidate may apply either for the province in which he has his private home or residence, or for the province in which he has taken his university course.

In that section of the will in which he defined the general type of scholar he desired, Mr. Rhodes mentioned four groups of qualities, the first two of which he considered most important.

(1) Literary and scholastic attainments;
(2) Qualities of manhood, truth, courage, devotion to duty, sympathy, kindliness, unselfishness, and fellowship;
(3) Exhibition of moral force of character and of instincts to lead and to take an interest in his fellows;
(4) Physical vigour, as shown by fondness for and success in outdoor sports.

Some definite quality of distinction, whether in intellect, character or personality, or in any combination of these, is the most important requirement. Financial need does not receive special consideration.

Forms of application and full information regarding these scholarships may be obtained from the Registrar, University of Toronto, or from the secretary of the Ontario Selection Committee, Alistair W. Gillespie, Esq., Suite 1602, 50 King St. W., Toronto. Selection is made in December for the following year and all applications must reach the provincial secretary before November 15 annually.

R.C.E. MEMORIAL SCHOLARSHIP

The Memorial Fund Committee of the Royal Canadian Engineers has established the R.C.E. Memorial Scholarship of a value of $125, open to students who have successfully completed their second to last year in the Faculty of Applied Science and Engineering or the School of Architecture.

A candidate must be

(*a*) a member in good standing of the Canadian Officers Training Corps and have successfully completed one summer season's training

or

(*b*) an ex-member of the Canadian Officers Training Corps who has successfully completed two years of C.O.T.C. Training and has transferred to the Canadian Army (Militia) or to the Canadian Army (Supplemental Reserve)

or

(*c*) a member of the Canadian Army (Regular) attending University under the Regular Officers Training Plan.

Selection is made on the basis of academic standing and of qualities of leadership.

Application forms may be obtained from the office of the Registrar.

REGULAR OFFICER TRAINING PLAN

Tenable in approved degree courses, this plan is available to Canadian citizens or British Subjects resident in Canada, who undertake to serve in the armed forces for at least four years after graduation. Accepted candidates will receive tuition, a book allowance of $75.00 and a living allowance of $143.00 per month during the academic session.

Application should be made to the Resident Staff Officer, 119 St. George Street, Toronto 5, or to the Canadian Forces Recruiting Centre, 25 St. Clair Avenue East, Toronto 7.

HELEN E. ROGERS ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of Helen E. Rogers open to students entering any degree course in the University. Preference is given to applicants from outside Ontario but failing such candidates awards may be made to qualified Ontario students. Recipients must have a standing satisfactory to the Committee of Award on first admission and may continue to enjoy the scholarship in the upper years provided they maintain first class standing. The value in each year is a minimum of $200 and a maximum of $1,500 dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

FREDERICK W. SCHUMACHER SCHOLARSHIP

The Frederick W. Schumacher Scholarship has been established in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must (*a*) be enrolled in the Second, Third or Fourth years in Mining Engineering or Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and (*b*) must have high academic standing.

Applications must be submitted to the University Registrar not later than October 15.

THE SCOTTISH RITE MASONS' BURSARY

The Scottish Rite Masons' Bursary, the gift of the Scottish Rite Masons of Toronto, of the value of $400 is awarded to a student enrolled in the Second Year who is a member of the Masonic Order, or a son, brother, nephew, daughter, sister or niece of a member of the Masonic Order. Consideration will be given to financial need and academic standing. Evidence of connection with the Masonic Order and information regarding financial need must be given with the application which must be submitted to the Secretary of the Faculty on or before October 15.

"SECOND MILE ENGINEER" AWARD

The Class of 3T5, convinced that a successful engineer must not only be professionally competent but also constantly aware of his responsibilities to humanity, and inspired by an address of President William E. Wickenden of the Case School of Applied Science, Cleveland, called "The Second Mile", which was based on the text from the Sermon on the Mount, "whosoever shall compel thee to go one mile, go with him twain" has established the "Second Mile Engineer" award. It is the desire of the donors to encourage undergraduates to participate fully in extra-curricular activities and to recognize the true importance of the more liberal subjects of the curriculum with the ultimate objective, on entering their profession, of becoming worthy Second Mile Engineers. The award comprises a grant of $200, a suitably inscribed presentation piece and an illuminated scroll, and is presented to a student in his final year.

An eligible group is chosen from those who have taken a prominent part in the affairs of the Faculty, either as office holders or in athletics. In making the award consideration is given to academic standing, with special emphasis on the candidate's attainments in the cultural and humanistic-social studies. The subjects which are stressed are English of the First Year; Economics of the Second Year; and Political Science and Modern World History of the Third Year.

Particulars are furnished each session by the Class of 1935.

THE SIMPSONS-SEARS LIMITED (NORTHERN ONTARIO) SCHOLARSHIPS

These scholarships, the gift of Simpsons-Sears Limited, are open only to students of the Copper Cliff High School, The Sudbury High and Technical Schools, the Sturgeon Falls High School, the North Bay Collegiate Institute and Vocational School, the Kapuskasing High School and all the Secondary Schools along the Ontario Northland Railway. A scholarship of the value of $100 is available for each of the schools mentioned and an additional sum of $50 will be given to the student who obtains the highest percentage of the nine papers of Grade XIII selected in accordance with the regulations.

No scholarship will be awarded unless the candidate is in actual attendance in one of the colleges or faculties of the University and maintains a uniformly high standard to the satisfaction of the donors of the scholarships.

Application for these scholarships must be sent not later than May 15, to the Principal of the North Bay Collegiate Institute and Vocational School, from whom further information may be obtained regarding conditions of award.

SOCIETY OF AUTOMOTIVE ENGINEERS PRIZE

The Ontario Section of the Society of Automotive Engineers offers an annual prize of the value of $100 to a student of the Fourth Year in any course whose thesis on a topic related to Automotive Engineering is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory.

SOCIETY OF CHEMICAL INDUSTRY MERIT AWARD

The Society of Chemical Industry Merit Award is made annually by the Society to the student in Fourth Year in the Department of Chemical Engineering who obtains the highest weighted average of marks in the results of the annual examinations for the year. The award is a gold key.

THE MURRAY F. SOUTHCOTE SCHOLARSHIP

Established by friends of the late Murray F. Southcote, a graduate of this Faculty (Aeronautical Engineering, 1950) this scholarship, which has a value of $100, is awarded in recognition of high standing at the Annual Examinations of the Third Year, in any course in the Faculty.

The first award was made in the Session 1964–65.

THE SPECIFICATION WRITERS ASSOCIATION SCHOLARSHIP IN CIVIL ENGINEERING

Donated by the Toronto Chapter of the Specification Writers Association of Canada, this scholarship has a value of $250 and is awarded to a student who achieves high standing, with honours, in the annual examinations of the Third Year in Civil Engineering.

The first award of this scholarship was made in the Session 1961–62.

SPRUCE FALLS POWER AND PAPER COMPANY LIMITED SCHOLARSHIPS

The Spruce Falls Power and Paper Company Limited has established four Scholarships of a value of $400 each, two in the Second Year and two in the Third Year. They are awarded on the results of the Annual Examinations of the Second and Third Years to the students who obtain honour standing at the examinations of their respective years and are open to students in all courses in the Faculty. The first awards were made on the results of the examinations of 1951.

Each scholarship carries a grant of $150 to the University General Funds.

WALTER STERLING ADMISSION SCHOLARSHIPS

Established in memory of Walter Sterling, these scholarships are open to students entering any first degree course at the University of Toronto. Recipients must obtain First Class Honours standing on the nine Ontario Grade XIII papers required for admission, and may continue to enjoy the scholarships in each year of their course providing they maintain Honour standing. The value of the scholarship is from $200 to $1,500 annually, dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University on the regular scholarship application form. The statement of financial need should be completed if an award greater than $200 is desired.

THE WILLIAM STORRIE MEMORIAL SCHOLARSHIPS IN CIVIL ENGINEERING

Three Scholarships have been established by Mrs. William Storrie in memory of her husband, the late William Storrie, a Consulting Engineer on many municipal projects in Canada and for several years a special lecturer in the Faculty of Applied Science and Engineering, for students in Civil Engineering, as follows:

(*a*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Second Year in Civil Engineering.

(*b*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Third Year in Civil Engineering.

(*c*) Of a value of $200 to the student who obtains the highest standing in the annual examinations of the Fourth Year in the Municipal and Sanitary Option of the course in Civil Engineering.

In all cases the candidates shall have demonstrated qualities of integrity and shown promise of leadership in their profession.

The first awards were made for the Session 1956–57.

TRANE COMPANY OF CANADA LIMITED PRIZE

The Trane Company of Canada, Limited, has established an annual prize of the value of $250 in the Faculty of Applied Science and Engineering. The award is made to the student in the Third Year of the course in Mechanical Engineering who obtains the highest aggregate standing in the subjects of Engineering Thermodynamics, Heat Engineering and Fluid Mechanics at the annual examinations of that year.

The award is tenable with other awards in the gift of the Senate. Application is not required.

EDITH TYRRELL MEMORIAL BURSARY

The Women's Association of the Mining Industry of Canada has presented this Bursary, having the value of $600, annually, commencing in 1939, and named in memory of their founder and first president, Mrs. Edith Tyrrell. A medal donated by Dr. Tyrrell accompanies the Bursary. The Bursary is awarded to a student entering the Third or Fourth Year in the Course in Metallurgy and Materials Science, or Geological Engineering; it may be awarded two years in succession to the same student, but will usually be awarded at the beginning of the Third Year. The award will be made by a special committee appointed by the Association on the following basis:

(*a*) In addition to mental capacity, the student must show leadership ability and give promise, through his activities, of becoming a worthwhile influence in the affairs of the profession and the community.

(*b*) While attention is given to scholastic ability, as evidenced by his academic standing, it is not the governing factor. He must, however, stand in the top quarter of his class.

(*c*) Special consideration is given to financial need.

Application must be made to the Secretary of the Faculty within one month of the opening of the academic year.

S. UBUKATA FUND

The S. Ubukata Fund for Japanese students was established to assist students from Japan proper to pursue a course of study at the University of Toronto. The fund provides grants of varying values on the basis of the information submitted by the applicants who:

(i) must be Japanese students from Japan proper;
(ii) must register in the University of Toronto devoting full time to their studies;
(iii) are able to satisfy admission requirements regarding English facility;
(iv) are not holding other financial aid.

UNIVERSITY OF TORONTO ALUMNI ASSOCIATION WAR MEMORIAL SCHOLARSHIPS

Six scholarships are awarded annually by the University of Toronto Alumni Association to students entering first degree courses at the University of Toronto. The scholarships have a value of $500 annually, and are tenable for two years, providing satisfactory academic standing is maintained. They are awarded for general proficiency in Grade XIII, and in addition to academic performance the committee of award will take into consideration the candidate's relationship to active service in the Armed Forces of Canada, need of financial assistance, participation in extra-curricular activities and such other qualifications as may commend themselves to the committee. One scholarship will be available to a student whose home is not in the Province of Ontario.

Students resident in Ontario may apply on the general admission scholarship form which must be submitted to the Registrar of the University not later than May 1. Evidence of relationship to active service in the Armed Forces of Canada should be attached. Students resident outside Ontario may obtain the necessary forms from the Awards Department, Office of the Registrar, University of Toronto.

UNIVERSITY NAVAL TRAINING DIVISION BURSARIES

The University Naval Training Division Bursaries, the gift of the University Naval Training Division, are of the value of $100 each. As many as three bursaries may be awarded in each session; if fewer than three are awarded those not awarded may be given in a subsequent session. A candidate must be registered in the University for a full-time course leading to a diploma or degree and must be at the time of the

award a member of one of the recognized military training units within the University. Application must be made to the University Registrar before the end of November.

UNIVERSITY OF TORONTO GENERAL BURSARIES

The Board of Governors has established a fund to provide bursaries for deserving students who without financial assistance cannot continue their formal education. Further information may be obtained from the Secretary of the Faculty.

THE U.T.S. ENGINEERING SCHOLARSHIP

The U.T.S. Engineering Scholarship, the gift of R. A. Bryce, Esq., of the value of $250. The scholarship will be awarded by a committee of the Staff of the University of Toronto Schools to a student of the Schools who has completed the requirements for admission to and enrols in the Faculty of Applied Science and Engineering.

WALLBERG ADMISSION SCHOLARSHIPS

Two admission scholarships, each of a value of $500 are awarded annually from the income from the Wallberg Bequest on the recommendation of the Council of the Faculty to the two candidates who obtain the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering; applicants are required to write the Problems paper for Scholarship candidates, but the standing on this paper will be used only as auxiliary information. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that this attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Applications must be submitted to the Registrar on the prescribed form by May 1.

WALLBERG UNDERGRADUATE SCHOLARSHIPS

These scholarships, four in number, of the value of $500 each, derived from the Wallberg Bequest, are awarded annually; two to students ranking first and second respectively at the annual examinations of the First Year; one to the student ranking first at the annual examinations

of the Second Year; and one to the student ranking first at the annual examinations of the Third Year.

Any holder of one of these scholarships may not hold other awards listed in the index with an asterisk. The awards were first made on the result of the annual examination of 1947.

W. S. WILSON MEDALS

These medals have been provided in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal will be awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of his course.

The first awards were made in the Session 1962–63.

WILLIAM R. WORTHINGTON MEMORIAL SCHOLARSHIP

The William R. Worthington Memorial Scholarship, the gift of Miss Ida R. Worthington, in memory of her brother, William R. Worthington, Dip.(1904), B.A.Sc.(1905), of the value of the income from a fund is awarded annually to the student of the Second Year in the course in Civil Engineering who ranks highest at the annual examinations of that year.

The first award was made at the examinations for the Session 1954–55.

LOAN FUNDS

From the loan funds mentioned below, small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must accordingly be restricted, both in amount and number, and principally to students in the Third and Fourth Years.

Enquiries for loans from any of the following funds should be made at the office of the Secretary of the Faculty.

Engineering Alumni Loan Fund
Engineering Society Loan Fund
Elizabeth Speller Memorial Fund
James W. Crocker Memorial Fund
Harry F. Bennett Educational Fund
S.A.E.—Canadian Section Loan Fund
Class of 2T7 (SPS) Memorial Loan Fund
Avro Aircraft Limited Engineering Loan Fund
Association of Professional Engineers Loan Fund
The William Storrie Memorial Fund
3T6 Engineers Loan Association
4T0 Engineering Loan Fund
Women's Association of the Mining Industry in Canada Loan Fund

The Devonshire Loan Fund
Class of '09 Trust Fund
University of Toronto Alumni Loan Fund
University of Toronto General Loan Fund

CLASS OF 1936 LOAN ASSOCIATION

Members of the Class of 1936 have made arrangements to assist students in obtaining loans through regular banking facilities. Information may be obtained from the Secretary of the Faculty.

ENGINEERING ALUMNI LOAN FUND

The Engineering Alumni Association established in 1950 a loan fund to assist engineering students, especially in the Third and Fourth Years.

Applications for loans from this fund should be made to the Secretary of the Faculty.

CLASS OF 2T7 (SPS) MEMORIAL LOAN FUND

This fund was established in 1955 to memorialize the Class of 1927 of the Faculty of Applied Science and Engineering.

Loans to a total of $250 are available to any undergraduate who has completed one Year, with or without conditions, and who has qualified for the Second, Third or Fourth Year.

Application shall be made to the Secretary of the Faculty.

ENGINEERING SOCIETY LOAN FUND

In 1932 the Engineering Society repaid to the Board of Governors a series of annual grants which, over a period of years, had been made to the Society for special purposes. The Board of Governors, appreciating this action, set aside this sum, to be known as the Engineering Society Loan Fund, to provide loans to students of the Faculty of Applied Science and Engineering. The administration of the fund is carried out by a Committee appointed by the Board. The fund is not large, and only small loans can be made to relatively few students. Further inquiries should be made at the office of the Secretary of the Faculty.

ELIZABETH SPELLER MEMORIAL FUND

Through the generosity of Dr. F. N. Speller, of the Class of 1893, the "Elizabeth Speller Memorial Fund" has been established to provide loans for worthy students of the Third and Fourth Years of this Faculty. Applications for loans from this Fund should be made to the Secretary of the Faculty.

JAMES W. CROCKER MEMORIAL LOAN FUND

This fund was established by Mrs. William Crocker in memory of her son, James W. Crocker, a graduate in Mining Engineering in 1938, who was killed in an accident in a mine in the same year.

HARRY F. BENNETT EDUCATIONAL FUND

This fund was established by subscription from members of The Engineering Institute of Canada in memory of the late Harry F. Bennett, M.E.I.C., who for six years prior to his death in 1946 was chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, and who accomplished so much in this field by untiring efforts.

One purpose of the fund is to make loans to deserving students who need financial assistance to enable them to study engineering sciences at university level, and who have proved themselves by successfully completing their first year in engineering or the equivalent.

Loans will be made largely on the basis of character and to men who seem likely to develop the high professional standards which are essential to leadership in engineering science. A student who has been aided by this fund should feel that high obligations are placed on him; obligations to the subscribers, to the trustees, and to those coming after him who in turn can receive help as his loan is repaid.

Application forms may be obtained at the Faculty Office. The regulations are simple and the application of any worth-while student will be given immediate and careful attention.

SOCIETY OF AUTOMOTIVE ENGINEERS—CANADIAN SECTION LOAN FUND

The Society of Automotive Engineers—Canadian Section has established a loan fund of $1,200 in the Faculty of Applied Science and Engineering. Preference is given to students in good scholastic standing and engaged in studies relative to the automotive and aircraft industries, and to students in fourth, third and second years in that order. Particulars may be obtained from the Secretary of the Faculty.

AVRO AIRCRAFT LIMITED ENGINEERING LOAN FUND

Avro Aircraft Limited has established a Loan Fund of $3,000 to provide loans to engineering students requiring financial assistance. Application should be made to the Secretary of the Faculty.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO LOAN FUND

The Association of Professional Engineers has made loans not exceeding $200 available to students in the First, Second and Third Years in this Faculty. Application should be made to the Association at 236 Avenue Road, Toronto.

THE WILLIAM STORRIE MEMORIAL FUND

The William Storrie Memorial Fund has been established by Mrs. William Storrie to provide loans to undergraduates in the course in Civil Engineering. Application should be made to the Secretary of the Faculty.

THE DEVONSHIRE LOAN FUND

This Fund has been established by Graduates and friends of Devonshire House to assist students in the Residence. Application should be made to the Office of the Dean of Devonshire House.

CLASS OF '09 TRUST FUND

The Class of '09 on the 50th Anniversary of their graduation made a sum of money available in the Faculty for financial aid to undergraduates, with preference to Second Year students. Inquiry should be made to the Secretary of the Faculty.

THE UNIVERSITY OF TORONTO ALUMNI LOAN FUND

This fund comes from subscriptions received originally in 1919 and in succeeding years from graduates of the University and is administered by the University of Toronto Alumni Association.

Loans are available to undergraduate and graduate students enrolled in a full time course at the University, in second and subsequent years.

Particulars may be obtained from The University of Toronto Alumni Association, Alumni House, 18 Willcocks Street, Toronto, or from the Secretary of the Faculty or School.

SECTION XI. DISCIPLINE

A SUMMARY OF THE REGULATIONS OF THE CAPUT CONCERNING STUDENT DISCIPLINE

1. Subject to the general regulations of the Caput of the University regarding jurisdiction in matters of discipline the Council of University College, the governing bodies of the Federated Universities and Affiliated Colleges, and the Councils of the Faculties, Schools, and Institutes have disciplinary jurisdiction over the conduct of all students registered in these Divisions of the University in all matters of local or internal concern to these Divisions. Jurisdiction over the conduct of students while in residence regardless of the Division of the University in which they are registered is vested in the body administering the residence.

2. Jurisdiction concerning conduct likely to affect the interests of the University as a whole is vested in the Caput.

3. The Students' Administrative Council will be supported in the proper performance of all its obligations and duties as provided in its Constitution.

4. Where the appropriate body exercising disciplinary jurisdiction has found that a student of the University has engaged in conduct prejudicial to the interests of the University, the Caput may, in its discretion, suspend or expel such student from the academic privileges of the University. Every decision of the Caput involving the expulsion of a student from the University requires confirmation of the Board of Governors.

5. Any student who interferes with the personal liberty of another or who subjects another student to indignity or personal violence may be considered by the Caput or any other body exercising disciplinary jurisdiction in the University to have committed a breach of discipline.

6. Initation ceremonies involving physical violence, personal indignity, interference with personal liberty, or destruction of property, may be deemed a breach of discipline by the Caput or any other body exercising disciplinary jurisdiction in the University.

7. Without limiting the disciplinary powers vested in the respective bodies exercising disciplinary jurisdiction as set forth in sections 1–7, the following are cited as illustrations of conduct which, in the past, has been considered a breach of discipline prejudicial to the interests of the University:

(i) The organising of a parade on the streets of the city or the taking part in such a parade without permission of the authorities.

(ii) The destruction or defacing of University property, raids on Residences or other University buildings, and the breaking into University buildings.

(iii) Rowdy and other forms of behaviour, either on or off the Campus, of such an objectionable nature as to bring the University into public disrepute.

8. Student Clubs and Associations

(a) The constitution of every society or association of students in the University and all amendments to such constitutions require to be approved by the relevant University authorities. The giving of approval, and the responsibility for the programmes of student societies and associations, shall rest as follows:

(i) With the authorities of the College, Faculty or School concerned where the membership of the student society or association is drawn from a single College, Faculty or School.

(ii) With the Board of Stewards of Hart House, where the student society or association is a Committee of Hart House and is controlled by the Board of Stewards of Hart House.

(iii) With the Caput, in the case of all other student societies and associations.

(b) No approval will be given by any of the authorities listed in (a) above to the constitution of any society or association of students if that constitution permits:

(i) Membership in the society or association to persons who are not students of the University, unless in the case of the societies listed in (a) (ii) above, where membership is open also to graduates of the University and members of the Faculty of the University.

(ii) Any action of discrimination based upon race, religion, or colour.

9. The name of the University is not to be used in connection with a publication of any kind without permission of the Caput.

SUMMARY OF STUDENTS IN ATTENDANCE

Session 1966–67

Courses		1	2	3	4	5	6	7	8	9	Total
Year	I	100	—	89	59	124	138	124	6	15	655
	II	59	—	63	70	40	94	83	15	9	433
	III	57	—	60	46	43	82	84	8	4	384
	IV	42	2	65	43	42	73	77	7	9	360
TOTAL		258	2	277	218	249	387	368	36	37	1832
Special Students											2
Diploma Course in Operations Research											11
											1845

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University of Toronto

Calendar 1968-1969
Faculty of Applied Science and Engineering

University of Toronto Press
1968

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CALENDAR 1968

January

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CALENDAR 1969

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FALL TERM, 1968

July 1	Monday	Dominion Day. Buildings closed.
August 5	Monday	Civic Holiday. Buildings closed.
August 12	Monday	Students of the III Year, Course 1, report at Survey Camp.
August 19	Monday	Students of the IV Year, Course 1, Option B, report at Survey Camp.
September 2	Monday	Labour Day. Buildings closed.
September 3	Tuesday	Fall Examinations commence. Students of the III Year, Course 9, report at Survey Camp.
September 4	Wednesday	Students in II Year, Course 6, report for Analytical Chemistry Lab.
September 12	Thursday	Registration in person of the I Year from 9:30 a.m. to 12 noon and from 2:00 p.m. to 4:30 p.m. in the Galbraith Building. Meeting of Faculty Council.
September 13	Friday	Registration in person of the II Year from 9:30 a.m. to 12 noon and of the III Year from 2:00 p.m. to 4:30 p.m. in the Galbraith Building. Dean's address to the I Year at 9:00 a.m. in Convocation Hall. Preliminary instruction to the I Year.
September 14	Saturday	Registration in person of the IV Year from 9:30 a.m. to 12 noon in the Galbraith Building.
September 16	Monday	Lectures and laboratory work commence at 9:00 a.m. Opening address by the President to the students of all Faculties at 2:00 p.m. in Convocation Hall. Lectures and laboratory classes withdrawn from 1:45 p.m. to 3:10 p.m.
October 1	Tuesday	Meeting of Faculty Council.
October 11	Friday	Meeting of Senate.
October 14	Monday	Thanksgiving Day. Buildings closed.

November 1	Friday	Meeting of Faculty Council.
November 8	Friday	Meeting of Senate.
November 11	Monday	Remembrance Day.
November 22	Friday	Fall Convocation.
December 4	Wednesday	Meeting of Faculty Council.
December 12	Thursday	IV Year Employment Interviews.
December 13	Friday	IV Year Employment Interviews.
		Meeting of Senate.
December 14	Saturday	IV Year Employment Interviews.
December 18	Wednesday	First Year Term Examinations commence.
December 20	Friday	Term ends at 5 p.m.
December 25	Wednesday	Christmas Day. Buildings closed.

SPRING TERM, 1969

January 1	Wednesday	New Year's Day. Buildings closed.
January 6	Monday	Spring term begins. Mid-session Examinations commence
January 10	Friday	Meeting of Senate.
January 13	Monday	Meeting of Faculty Council.
January 15	Wednesday	Last day for receiving the second term instalment of fees.
February 4	Tuesday	Meeting of Faculty Council.
February 14	Friday	Meeting of Senate.
February 17	Monday	
to		
February 21	Friday	Study week. Lectures and laboratory classes withdrawn.
March 5	Wednesday	Meeting of Faculty Council.
March 14	Friday	Meeting of Senate.
April 3	Thursday	Meeting of Faculty Council.
April 4	Friday	Good Friday. Buildings closed.
April 11	Friday	Term ends at 5 p.m.
		Meeting of Senate.
April 21	Monday	Annual Examinations commence.
May 1	Thursday	Meeting of Faculty Council.
May 9	Friday	Meeting of Senate.
May 19	Monday	Victoria Day. Buildings closed.
May 30	Friday	Opening of Convocation.

II The Faculty of Applied Science and Engineering

ADMINISTRATIVE STAFF

Dean: J. M. Ham, B.A.SC., S.M., SC.D.(M.I.T.)
Associate Dean: W. F. Graydon, M.A.SC., PH.D.(MINN.)
Assistant Dean and Secretary: J. A. Gow, B.A.SC.
Assistant Secretary: W. J. Dowkes, B.A.SC.

The Faculty of Applied Science and Engineering in the University of Toronto offers the widest range of undergraduate and postgraduate studies in engineering in Canada. The four year Bachelor of Applied Science (B.A.Sc.) undergraduate program is offered in Civil, Chemical, Electrical, Geological, Industrial and Mechanical Engineering, in Metallurgy and Materials Science and in Engineering Science. The Engineering Science program offers specific options in Aerospace, Chemical, Computer Science, Electrical, Geophysics, Materials Science, Nuclear and Thermal Power and Physics.

The Faculty offers a Diploma in Operations Research, and, through the School of Graduate Studies, postgraduate programs for the Master of Applied Science (M.A.Sc.), the Master of Engineering (M.Eng.) and the Doctor of Philosophy (Ph.D.). Through the immense diversity of the resources of the University it is possible to do research in bio-engineering (engineering and medicine), in environmental engineering (urban planning and the control of pollution in air, water and land), in the history of technology, etc. This remarkable pattern of bridges linking the arts, sciences and professions in studies of man, his ideas and works adds a distinctive vitality and range to engineering at Toronto.

There are some 2100 undergraduate students and 600 postgraduate students. Undergraduates are taught not only by the staff of the Faculty but also by staff of University departments of Chemistry, Geology, Mathematics, Physics, English, History, Philosophy and Political Economy. On the staff of the Faculty alone there are some 160 professors.

From its historic beginnings in the School of Practical Science (S.P.S.) in the eighteen seventies, the Faculty has grown since 1906 as an integral and senior part of the University. For students an important historical fact is that the Engineering Society, the

student society of the Faculty, with its "Cannon" and "LGMB" band, is the oldes engineering organization of any formal kind in Canada.

The Faculty is located on the main campus in a rectangle bounded on the south by College Street, the west by St. George Street, the north by Convocation Hall and on the east by Taddle Creek Road where, in the days of Canadian Confederation there was indeed a creek so named.

The administrative offices are located in the southwest corner of the Galbraith Building at 35 St. George Street. Students and visitors are invited to seek assistance here

SUMMARY OF STUDENTS IN ATTENDANCE – *Session 1967-68*

COURSE		1	3	4	5	6	7	8	9	TOTAL
Year	I	101	115	67	147	141	169	10	15	765
	II	82	90	100	55	100	110	7	11	555
	III	55	63	60	36	81	76	12	6	389
	IV	55	55	40	40	75	73	6	4	348
TOTAL		293	323	267	278	397	428	35	36	2057
Special Students										7
Diploma Course in Operations Research										6

III General Information Admission and Registration

Full details of the University of Toronto undergraduate admissions are contained in the undergraduate Admission Circular 1968–69 obtainable on request from the Office of Admissions, University of Toronto, Toronto 5, and available in all Ontario secondary schools. Inquiries about admission to the Faculty of Applied Science and Engineering should be directed to the above-mentioned office.

The right is reserved to limit the number of students admitted to any course in the Faculty.

1. ADMISSION REQUIREMENTS

ONTARIO GRADE 13 REQUIREMENTS:

Standing in the following subjects, with an overall average of 70% for Engineering Science, and 64% for all other courses:

Mathematics (A and B); Physics; Chemistry; and an additional subject or subjects comprising 2 credits selected from the Grade 13 subjects approved for purposes of admission to the University.

Note: If a seven-credit programme is presented, at least five of the seven credits must have been obtained in 1967 or 1968; otherwise the candidate must present nine credits which must include the subjects specified above.

ONTARIO GRADE 12 PRESCRIPTION:

Ontario Grade 13 candidates must also have Grade 12 standing in at least six subjects (excluding Physical Education). The subjects chosen must include at least five of the following subjects and at least one subject from each of the four groups:

(*a*) English

(*b*) French; German; Greek; Italian; Latin; Russian; Spanish

(*c*) Geography (Parts 1 and 2); History (Parts 1 and 2)

(*d*) Mathematics (Parts 1 and 2); Science (Physics and Chemistry)

Note: For admission to the 1968–69 Session, applications will be considered from candidates who find it impossible to meet the requirements of group (d) because of the program taken in Grade 11 in 1965–66.

2. APTITUDE AND ACHIEVEMENT TESTS

Ontario students will present the results of all standardized tests offered in the secondary schools. Other students may improve their competitive position by taking the aptitude test of the College Entrance Examination Board, Box 592, Princeton, New Jersey 08540, U.S.A.

3. EQUIVALENT CERTIFICATES

The following certificates are usually accepted as equivalent to Ontario Grade 13 although individual subjects cannot always be equated. Candidates offering Senior Matriculation programmes from provinces other than Ontario must offer at least five subjects and satisfy the subject requirements specified for the course of their choice. Specific details on subjects and standards required for the course must be requested well in advance of the application deadline.

CANADA:

Alberta, Manitoba, Nova Scotia, Saskatchewan – Grade 12.
British Columbia, New Brunswick – Grade 13.
Newfoundland – First Year Memorial University.
Prince Edward Island – First Year University at Prince of Wales College.
Quebec – Senior High School Leaving Certificate; McGill Senior School Certificate; English Catholic Senior High School Leaving Certificate (5th Year High – Grade 12). Other certificates will be considered.

ENGLAND, WEST INDIES, EAST AND WEST AFRICA

(*a*) General Certificate of Education showing either
(i) Passes in five subjects of which at least two must be passed at advanced level; or
(ii) Passes in four subjects of which at least three must be passed at advanced level.
In either case, passes are required in Physics, Chemistry, and an acceptable mathematical subject. At least two of these must be at advanced level.
or (*b*) School and Higher School Certificates, which are equated to the General Certificate of Education as follows, and accepted on that basis:
Credits on the School Certificate are accepted as ordinary level passes on the General Certificate of Education; subsidiary passes on the Higher School Certificate as ordinary level passes on the General Certificate of Education; and principal or main subject passes on the Higher School Certificate as advanced level passes on the General Certificate of Education.

HONG KONG:

(*a*) General Certificate of Education or School and Higher School Certificates as stated above; or

(*b*) University of Hong Kong Matriculation Certificate, accepted on the same basis as General Certificate of Education.
(*c*) Hong Kong English School Certificate (from 1965 onward) in conjunction with (*a*) or (*b*).
Note: Hong Kong English School Certificates issued prior to 1965 are not acceptable for admission purposes.

UNITED STATES OF AMERICA:

First Year University credits (a minimum of 30 semester hours) in the required subjects from accredited institutions of higher learning. A United States High School Graduation Diploma will not normally admit a candidate to any course. Advanced Placement work will, however, be considered.

4. ENGLISH FACILITY REQUIREMENTS

All applicants are required to submit evidence of facility in English. Candidates whose mother tongue is not English may be required to meet an appropriate standard in a recognized English facility test. The following evidence is acceptable:

(*a*) The University of Michigan English Language Test. This test is available at the University of Toronto for residents of the Toronto area. Enquiries about writing the test in Toronto should be addressed to the Office of Admissions, Simcoe Hall, University of Toronto.

(*b*) The Certificate of Proficiency in English issued by the Universities of Cambridge or Michigan.

Information about writing the tests in (*a*) or (*b*) above in overseas centres may be obtained from the Office of Admissions, Simcoe Hall, University of Toronto.

The University is prepared to consider other evidence of English facility which may be submitted for evaluation to the Office of Admissions.

5. MATURE STUDENTS

Candidates 25 years of age or older who have lived in Ontario for a minimum period of one year may request special consideration if they have not completed the regular admission requirements in full. In order to be admitted to the Faculty of Applied Science and Engineering all such candidates must have Grade 13 or equivalent preparation in mathematics, physics and chemistry. Interested candidates should consult the Office of Admissions for further information.

6. APPLICATION PROCEDURES

All Candidates must submit an application form and supporting documents to the Office of Admissions, University of Toronto, Toronto 5.

Supporting documents include all final secondary school certificates held. These certificates must indicate the subjects studied and grades obtained. If a certificate is not available at the time of application, candidates must indicate the exact name of the certificate to be presented for admission, and the subjects included therein, as well as the approximate date available. A notarized English translation must accompany certificates which are in a language other than English or French.

In addition a student who has previously attended a University must submit the following:

(*a*) Official transcripts issued by the University or College previously attended, giving in detail the courses completed, with the standing and grades in each. Transcripts or a supporting letter from the Registrar of the University or College must indicate that the candidate has been granted honourable dismissal and is eligible for re-admission to the institution concerned in the session for which he seeks admission to the University of Toronto;

(*b*) Official statements or calendars giving full information on the content of the University courses covered by the transcripts submitted.

For application forms and further information about admission requirements, consult the Office of Admissions, stating in the first letter what credentials will be offered with a listing of subjects and grades obtained.

The closing date for the receipt of applications is June 1. Only in circumstances which the Committee on Admissions deems exceptional will a late application be considered.

7. EARLY ADMISSION

(Ontario Grade 13 students only)

Ontario Grade 13 students with good school records may be offered admission as early as May 15.

Students wishing to be considered for Early Admission should ensure that their applications are forwarded by their schools not later than March 1.

8. CANDIDATES WHO HAVE PREVIOUSLY FAILED IN UNIVERSITY WORK

Candidates with a previous failure in university work may be considered individually on their merits; candidates with two previous failures are normally refused admission.

9. PROCEDURE FOR REGISTRATION

Detailed instructions concerning registration will be mailed to returning and newly admitted students before the beginning of each academic year.

10. HEALTH REQUIREMENTS

Every person admitted to the University as an undergraduate must, at the time of his

or her first medical examination by the University Health Service, present satisfactory evidence of successful vaccination within three years prior to the date of the examination, or must be vaccinated by the examining physician.

COLLEGES

With the establishement of New College and Innis College, which are open to students of all faculties, it is now possible for students of the Faculty of Applied Science and Engineering to become members of a college. Membership in a college is not obligatory, and application for membership is at the option of the student.

Students entering the First Year who are interested in becoming members of either college should indicate their choice in the space provided on the University's admission application form. A college fee of $15 is required upon acceptance.

The facilities of Innis College and New College are described below.

INNIS COLLEGE

Innis College was constituted on July 1, 1964, and admitted its first students in the following September. It is a multi-faculty college of the University of Toronto, and includes undergraduate students in all Faculties and Schools of the University.

A special feature is the Writing Laboratory. This service offers assistance to Innis College students in the skills and methods of writing essays and other academic reports. A staff of experienced teachers is available to give individual instruction.

NEW COLLEGE

New College is a multi-faculty co-educational college; in addition to students from the Faculty of Arts and Science those from other Faculties and Schools are eligible for membership. This gives students from all divisions of the University the opportunity to participate in the activities of a college and to associate with students in other fields of study. Tutorial classes are provided for First Year students in some subjects.

The new building, centrally located on the west campus, provides academic, social and dining facilities for all members of the College and in addition accommodates nearly 300 male students in residence.

Students applying for membership in the College who wish accommodation in the Residence must apply on the prescribed form which may be obtained from the Dean of Students, New College.

RESIDENCE ACCOMMODATION

DEVONSHIRE HOUSE

Devonshire House, the University Residence for Men, accepts students from all

Faculties. The facilities of the residence include a library, music listening room, music practice room, common rooms, kitchenettes, laundry room, television and games rooms. It does not have a dining hall. Members may take their meals at Hart House, Howard Ferguson Hall, or New College, all located nearby.

Application forms may be obtained from the Secretary to the Dean, Devonshire House, University of Toronto. Applciation should be made as early as possible.

NEW COLLEGE

The residence facilities of New College, and the procedure for application, are described in the entry under Colleges, above.

Each of the four Arts Colleges also maintains a Men's Residence, into which some engineering students may be accepted. Further information may be obtained from

University College – Dean of Men
Victoria College – Senior Tutor
Trinity College – Registrar, Trinity College
St. Michael's College – Dean of Men

HOUSING SERVICE

For the convenience of those students who are not able to find accommodation in the University and College residences, the University Housing Service maintains a listing of rooming houses, flats, apartments and homes. Information may be obtained by telephoning 928-2542.

Off-campus housing of this nature is not subject to University regulation. However every effort is taken to make the information on the accommodation as complete as possible and students are encouraged to assist in this effort by reporting on the quality of the accommodation that they have occupied.

CAMPUS CO-OPERATIVE RESIDENCE INCORPORATED offers residence and apartment accommodation for graduate and undergraduate students. Total occupancy is 300 in residence, half male, half female, and 50 in apartments. Meals are provided, and non-residents are invited to eat at the Co-op Dining Rooms. Since the University of Toronto has no official conection with Campus Co-operative Residence, Inc., inquiries should be addressed direct to

Campus Co-operative Residence Incorporated
395 Huron Street
Toronto 5, Ontario
Tel.: 921-3168

ROCHDALE COLLEGE will open in September, 1968, to offer student accommodation of varying forms. Single and double rooms, suites, and apartments will be offered at reasonable rates. Total accommodation will be about 850 students, both male and female. A large cafeteria is contained within the building. Students may take advantage of the educational program of Rochdale College on either a full or part-time basis if they so

desire. Rochdale College will be operated on the co-operative system. Since the University of Toronto has no official connection with Rochdale College, all inquiries should be addressed direct to

Rochdale College
Reservations Office
395 Huron Street
Toronto 5, Ontario
Tel.: 921-3168

IV Fees, Deposits and Expenses

FEES

1. Undergraduate students in the Faculty of Applied Science and Engineering must pay annual fees according to the schedule listed below. The total fee in each case is made up of the academic fee and incidental fees; all incidental fees are payable in the first term.

Students will receive by mail in August a fees form and instructions for the payment of fees. In order to avoid delay in registration at the opening of the session it is recommended that at least the first term instalment of fees be forwarded by mail as early as possible in September.

Fees may be paid by certified cheque, money order or personal cheque payable to the University of Toronto at par, and mailed to the Chief Accountant, University of Toronto, Toronto 5.

2. Payment of at least the First Term instalment must be made on or before the opening day of the session. An admit-to-lectures card cannot be issued until the student has complied with this requirement.

3. The Second Term instalment of fees, if not already paid, is due on the opening day of the second term and must be paid not later than January 15. After this date an additional fee of $3 per month or portion thereof (not exceeding $10), will be imposed until the whole amount is paid. All fees for the session must have been paid in full before the student can be admitted to the annual examinations.

4. Adjustment of fees for students who withdraw is made up to the twenty-fourth week of the session.

5. Fees, residence dues and other charges set forth in this calendar are subject to change by the Board of Governors.

SCHEDULE OF FEES

Men

Academic Year	*Academic Fee	†Incidental Fees	Total Fee (if paid in one instalment)	First Term Instalment	Second Term Instalment
I–IV	$650	$63	$713	$388	$328

Women					
I–IV	$650	$35	$685	$360	$328

*The Academic Fee includes the following fees:
Tuition; Library and Laboratory Supply; one Annual Examination; Laboratory Fee; and Degree.
†These Incidental Fees include the following fees:
For men – Hart House; Students' Administrative Council; Athletic; Health Service; Engineering Society; Faculty Athletic Association.
For women – Students' Administrative Council; Athletic; Health Service; Engineering Society.

LATE REGISTRATION FEE

Any student who registers after the last date for normal registration in his or her own faculty or school is required to pay a late registration fee of $10 plus $1 for each day of delay to a maximum of $20.

OTHER UNIVERSITY FEES

Each student is required to pay to the Chief Accountant at the opening of the session, or as otherwise specified, such of the following fees as may be required of him.

EQUIVALENT CERTIFICATE FEE

Each student who has been admitted to the First Year upon a certificate or certificates granted outside the Province of Ontario and covering all or any part of the admission requirements, must pay a fee of $5.

ADVANCED STANDING FEE

Each student who has been admitted to advanced standing from another university or college, must pay a fee of $10.

SPECIAL STUDENTS FEES

The fee is $95 per subject, payable to the Chief Accountant.

SUMMARY OF STUDENTS' EXPENSES

The following approximate statement of expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering in the University of Toronto, exclusive of personal expenses:

1. Fees, see schedule page 16.
2. Board and Lodging, per week ..... $25 up
3. Books and instruments, per year ..... about $135

V Courses and Degrees

UNDERGRADUATE COURSES

The Faculty offers the following courses leading to the degree of Bachelor of Applied Science:

Civil Engineering (Course 1)
Mechanical Engineering (Course 3)
Industrial Engineering (Course 4)
Engineering Science (Course 5)
Chemical Engineering (Course 6)
Electrical Engineering (Course 7)
Metallurgy and Materials Science (Course 8)
Geological Engineering (Course 9)
Aerospace Engineering (offered as an option in Engineering Science. See page 56.)

The curricula of the various courses are set out in detail in Section VI. The courses extend over four academic sessions. Full time attendance during the academic session is required; the Faculty does not offer part-time or evening courses leading to the degree.

GRADUATE STUDY AND RESEARCH

Facilities are available in the Departments of the Faculty for postgraduate study and research leading to the degrees of Master of Engineering (M.Eng.), Master of Applied Science (M.A.Sc.), and Doctor of Philosophy (Ph.D.). For further information see the Calendar of the School of Graduate Studies.

DIPLOMA COURSE IN OPERATIONS RESEARCH

A one-year diploma course in Operations Research is offered for those who have obtained a bachelor's degree in engineering, science, or mathematics. The diploma course is designed specifically to meet the needs of people who are presently employed in industry and who aspire to develop special skills in the design, analysis, and control

of complex organizational systems. The course may not be offered in a particular session if conditions prevailing render it impracticable to do so.

Inquiries regarding the Diploma Course in Operations Research should be directed to the Secretary, Faculty of Applied Science and Engineering.

SPECIAL STUDENTS

Graduates of the University of Toronto and of recognized universities who wish to take one or more undergraduate subjects may be registered as special students in the Faculty of Applied Science and Engineering, subject to the approval of the teaching department concerned. Application must be made to the Secretary of the Faculty.

INTERIM HIGH SCHOOL ASSISTANT'S CERTIFICATE TYPE A

Graduates of engineering courses may be admitted to Type A certificate courses at the College of Education, University of Toronto, if they submit official transcripts which indicate that they have sufficient academic credits.

Graduates of engineering courses who lack sufficient academic credits for admission to Type A courses at the College of Education may be eligible for admission to the Type B course and later for endorsement of the Type B certificate.

Inquiries regarding admission to the Type B course should be addressed to the Registrar, the College of Education, University of Toronto. Inquiries regarding endorsement of Type B certificates or admission to Type A certificate courses should be addressed to the Director, Committee on Advanced Standing, the College of Education, University of Toronto.

ASSOCIATIONS OF PROFESSIONAL ENGINEERS

Graduation from the Faculty of Applied Science and Engineering leads to registration as a Professional Engineer in the various Associations of Professional Engineers throughout Canada.

VI Curriculum

In this era of rapid technological change, the professional role of engineering is to build bridges between the world of science and the world of men, and to do so with ingenuity, economy and sensitivity. The talent of the engineer is an amalgam of curiosity, physical insight, capacity for mathematical analysis, ability to work with people and to develop effective designs to achieve particular goals.

The early years of the four-year curriculum are designed to give students a command of the basic scientific principles upon which effective solutions to engineering problems are based. Although specialization into particular fields of study increases in the third and fourth years, the essential purpose of every academic program is to open the student's mind out to those general qualities which distinguish good engineering of any kind. These qualities transcend in importance the particular subject content in which they are projected.

On the following pages of this section, the curriculum for each course is set forth in detail. The time devoted to lectures and practical work is indicated as accurately as possible, but is subject to modification as occasion may require. The program and regulations regarding the courses of study and examination, contained in this Calendar, hold good for this academic year only, and the Faculty of Applied Science and Engineering does not bind itself to adhere for the whole period of a student's course to the conditions here laid down.

Communications relating to curricula, instruction, and examinations in the Faculty of Applied Science and Engineering should be sent to the Secretary of the Faculty.

For information regarding the courses of study leading to the post-graduate degrees, Master of Engineering, Master of Applied Science, and Doctor of Philosophy, see the calendar of the School of Graduate Studies, which gives full particulars.

FIRST YEAR CURRICULUM

The courses in Civil Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering, Metallurgy and Materials Science, and Geological Engineering are designated as Division A and have a common First Year. The First Year curriculum in Engineering Science is designated as Division B.

A student who has sucessfully completed the First Year in Division A may transfer to any other course within that Division at the beginning of the Second Year, subject to the availability of places; a student who has successfully completed the First Year in Division B will likewise be permitted to transfer to any course in Division A, subject to the availability of places.

Students wishing to transfer should make application to the Secretary of the Faculty not later than August 15.

FIRST YEAR CURRICULUM – DIVISION A

Civil Engineering
Mechanical Engineering
Industrial Engineering
Chemical Engineering
Electrical Engineering
Metallurgy and Materials Science
Geological Engineering

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemistry	600, 601	2	3	2	3
Engineering Graphics	135	1	3	1	3
English	2110	2	–	2	–
Mathematics:					
Algebra and Analytic Geometry	2410	2	1	2	1
Calculus	2411	2	1	2	1
Engineering Applications of Mathematics	13	–	2	–	1
Computer Programming	3310	–	–	1	1
Physics:					
Electricity	700	2	¾	2	¾
Applied Mechanics	100	2	¾	2	¾
Structure and Properties of Matter	2501	2	1½	2	1½
Engineering Seminars	11	–	½	–	½

FIRST YEAR CURRICULUM — DIVISION B
Engineering Science

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemistry	602, 601	2	3	2	3
Engineering Graphics	135	1	3	1	3
English	2110	2	–	2	–
Mathematics:					
Algebra and Geometry	2415	2	3	2	3
Calculus	2416	2		2	
Computer Programming	3310	–	–	1	1
Physics:					
Electricity	701	2	–	2	–
Statics	101	2	–	–	–
Properties of Matter; Mechanics and Heat	2511, 2512	3	4	3	4
Engineering Seminars	11	–	½	–	½

Civil Engineering

STAFF OF THE DEPARTMENT

Professor and Chairman of the Department:
T. C. Kenney, B.ENG.(MC.G.), D.I.C.(IMP.), M.SC.(LOND.), PH.D.(LOND.)

Associate Professor and Assistant Chairman of the Department:
S. M. Uzumeri, M.A.SC.

Professors:
F. A. DeLory, B.ENG.(MC.G.), M.A.SC., D.I.C.(IMP.), PH.D.(LOND.)
M. W. Huggins, M.A.SC.
G. Kani, DR.ING.(STUTTGART)
O. J.Marshall, B.A.SC., C.E., O.L.S.
H. R. Rice, B.SC.(QU.)

Associate Professors:
J. D. Barber, C.D., M.A.SC.
A. P. Bernhart, DIP. ING.(GRAZ.), DR.TECH.(GRAZ.)
R. A. Collins, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
A. C. Davidson, B.SC., C.E., B.SC., E.E.(MAN.), M.A.SC.
M. M. Davis, B.SC.(QU.), M.SC.(PURDUE)
H. R. Frizzle, B.SC., E.E.(N.S.TECH)
B. J. Haynes, B.A.SC., O.L.S.
C. Hershfield, B.SC., C.E.(MAN.), M.A.SC.
P. H. Jones, B.A.SC., M.S.(NORTHWEST.), PH.D.(NORTHWEST.)
D. J. L. Kennedy, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
H. L. Macklin, B.A.SC., O.L.S., D.L.S.
E. I. Robinsky, B.A.(BEIRUT), B.SC.(BEIRUT), M.S.(HARVARD), PH.D.
J. Schwaighofer, DIP. ING.(GRAZ.), M.S.(PENN. ST.), PH.D.(PENN. ST.), DR. TECH.(GRAZ.)
K. A. Selby, B.A.SC., M.B.A., PH.D.(ILL.)

R. M. Soberman, B.SC.(DALH.), S.M.(M.I.T.), PH.D.(M.I.T.)
J. Vlcek, B.SC.F.(N.B.), M.A.SC.
C. A. Wrenshall, B.E.(SASK.)
P. M. Wright, B.E.(SASK.), M.SC., PH.D.(COL.)

Assistant Professors:
S. J. G. Bird, M.A.SC., O.L.S.
R. C. Gunn, M.A.SC.
G. W. Heinke, M.A.SC.
K. Meipoom, M.A.SC.
J. Timusk, M.A.SC.

Lecturers:
V. P. Borecky, DIP. ING.(PRAGUE), M.A.
E. Karuks, M.A.SC.
R. G. Rice, B.A.SC., M.SC.(M.I.T.)
R. G. Tress, M.A.SC.

Special Lecturers:
W. E. Carswell, B.ARCH.
C. E. Helwig, M.A.SC.
N. Irwin, B.A.SC.
B. Marrus, B.SC.(CORNELL)
G. K. Rodgers, B.A.SC., M.SC.(U.B.C.), PH.D.

CIVIL ENGINEERING

Course 1

The course in Civil Engineering has been so designed as to be broad and comprehensive. It has been designed not only to meet the needs of those who have definitely decided to enter this branch of the profession, but also of those who desire an engineering education of such a basic character as to enable them to enter various other fields of engineering employment.

In addition to instruction in engineering subjects, sufficient time is assigned to economic, legal and administrative studies to qualify the graduate in this course not only to engage in any of the branches of Civil Engineering but also to do administrative or executive work in industrial, commercial, government or other undertakings of an engineering character.

In the final year three options are offered:

A – Structural
B – Surveying
C – Geotechnical, Municipal and Transportation

Because of the common core of Civil Engineering material in the course, a graduate in any option will not be at a serious disadvantage when engaged in engineering work that is morely closely associated with one of the other options.

Most of the subjects in the Third Year are taken by all students, but, in addition to these common subjects, students proceeding to options A and C in the Fourth Year must take the Group A subjects while those proceeding to option B must take the Group B subjects.

For the First Year curriculum see Division A, page 21.

SECOND YEAR CIVIL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2420	2	1	2	1
Computer Programming	145	2	2	–	–
Dynamics	350	1½	–	–	–
Economics	2720	2	–	2	–
Electrical Engineering	724	–	–	2	–
Engineering Chemistry	607	2	–	–	–
Engineering Graphics	138	–	4½	–	4
Engineering Optics and Astronomy	152	1	–	1	1½
Engineering Thermodynamics	302	–	–	1½	–
Geology for Engineers	2900	2	–	1	3
Mechanics of Materials	105, 104	2	–	2	3
Physical Metallurgy	815	–	–	2	–
Practical Experience	20	–	–	–	–
Surveying	153	2	4	1	3

Each student in Civil Engineering is required to state, not later than June 30 following the completion of his Second Year, the group of subjects he desires to pursue in the Third Year. Permission to take either group of subjects must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

THIRD YEAR CIVIL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Fluid Mechanics	333	2	–	2	3
Highway Engineering I	185	2	1½	–	–
Engineering Mathematics	141, 139	2	1½	2	3
Municipal Planning, Administration and Transportation	186	–	–	3	–
Practical Experience	20	–	–	–	–
Sanitary Engineering	180	2	–	–	–
Soil Mechanics	191	2	1½	–	–
Survey Camp	158	–	–	–	–
One of					
History	2330 or 2332	2	–	2	–
Political Science	2730				
And either of the following group of subjects:					
GROUP A (Leading to options 1A and 1C)					
Mechánics of Materials II	110, 113	2		2	
Structural Design I	111, 113	2	7½	2	6
Structural Theory I	112, 113	–		3	
GROUP B (Leading to option 1B)					
Geodetic Engineering	160, 161	–	–	2	3
Least Squares	159	–	3	–	–
Photogrammetry I	162, 163	2	3	–	–
Photo Interpretation	164, 165	–	–	2	3
Structural Design I	111, 115	2	1½	2	3

Civil Engineering students selecting the Group A subjects are required to state not later than June 30 following the completion of their Third Year the options (one of options 1A or 1C) they desire to pursue in the Fourth Year. Permission to enter upon an option must be sought from the Council. This may be withheld if the number of students offering, or conditions existing at the time, render it impracticable to give this work.

Civil Engineering students selecting the Group B subjects in their Third Year must pursue option 1B in their Fourth Year.

FOURTH YEAR CIVIL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Construction Management	130	–	–	2	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Hydraulic Engineering	343	2	3	–	–
Philosophy and Science	2040	2	–	–	–
And one of the following options:					
OPTION 1A (Structural)					
Behaviour and Design of Steel Structures	118	2	2	2	2
Mathematical Applications	140	–	–	2	1½
Reinforced Concrete I	116	2	1½	2	1
Reinforced Concrete II	117	2	1	2	1
Soil Mechanics and Foundations	192	2	–	1	2
Structural Theory II	119	2	2	3	2
Thesis Project and Mechanics of Materials Laboratory	40, 120	–	4	–	4
OPTION 1B (Surveying)					
Astronomy	172	–	–	1	3
Engineering and Legal Surveys	174	1	–	2	–
Geodesy and Electronic Surveying	175	2	1½	2	3
Geodetic Adjustments	168	1	3	1	3
Photogrammetry II	170	1	3	1	1½
Structural Engineering II	122	2	4½	2	3
Survey Camp	167	–	–	–	–
Town and Regional Planning	3540	1	3	1	3
Thesis	40	–	–	–	1
OPTION 1C (Geotechnical, Municipal and Transportation)					
Mathematical Applications	140	–	–	2	1½
Reinforced Concrete I	116	2	3	2	3
Soil Mechanics and Foundations	192	2	–	1	2
Thesis	40	–	2	–	4½
Elective		3	2	–	–
Elective		3	2	–	–
Elective		–	–	3	2
Elective		–	–	3	2

*First Term Electives** (choose 2)

Air Photo Interpretation	189
Engineering Geology	194
Environmental Planning	184
Pollution Control Sciences	181
Traffic Engineering	187

*Second Term Electives** (choose 2)

Foundations and Earthworks	193
Municipal Engineering	182
Pollution Control Engineering	183
Transportation Engineering	188

*In special cases, depending upon student interest and staff availability, one or more electives *may* be offered both terms, or not at all.

Mechanical Engineering

STAFF OF THE DEPARTMENT

Professor and Head of the Department:

G. R. Lord, B.A.SC., S.M.(M.I.T.), PH.D.

Professors:

W. D. Baines, B.SC.(ALTA.), M.S., PH.D.(IOWA)

F. C. Hooper, B.A.SC., D.I.C.(LOND.)

P. B. Hughes, B.SC.(MCG.)

L. E. Jones, B.SC.(C.E.)(MAN.), M.A.SC., PH.D.

F. P. J. Rimrott, DIP. ING.(KARLSRUHE), M.A.SC., PH.D.(PENN. STATE), DR. ING.(DARMSTADT)

I. W. Smith, M.A.SC.

Associate Professors:

A. B. Allan, M.A.SC.

J. F. Keffer, M.A.SC., PH.D.

H. J. Leutheusser, DIP. ING.(KARLSRUHE), M.A.SC., PH.D.

J. Van de Vegte, DIP. ING.(DELFT), M.A.SC, PH.D.

R. T. Waines, B.A.SC.

Assistant Professors:

A. H. Abdelmessih, B.M.E.(CAIRO), M.S.(OKLAHOMA STATE), PH.D.

D. L. Allen, B.SC.(DAL.), B.E.(N.S. TECH.), M.A.SC., PH.D.

I. G. Currie, B.SC.(STRATHCLYDE), M.A.SC.(B.C.), PH.D. (CAL.I.T.)

G. E. Godfrey, M.A.SC.

D. F. James, B.SC.(QUEEN'S), M.S.(CAL. TECH.), PH.D.(CAL. TECH.)

D. S. Scott, B.SC.(QUEEN'S), M.SC.(QUEEN'S), PH.D.(NORTHWESTERN)

P. S. Shen, B.SC.(LOND.), M.SC.(BIRMINGHAM), PH.D.(LOND.)

B. Tabarrok, B.SC.(WOLVER. & STAFF.), D.PHIL.(OXON)

C. A. Ward, B.SC.(TEX.), PH.D.(NORTHWEST.)

Special Lecturer:

F. E. Burke, B.A.(LOND.).

MECHANICAL ENGINEERING

Course 3

Traditionally associated with the art and science of power generation and the machines and devices by which power is usefully applied and controlled, Mechanical Engineering, like other branches of the engineering profession, participates actively in the advancement of knowledge and interprets this knowledge in the design and development of practical systems.

In manufacturing industry, in the transportation and power utilities, in the high-performance field of air and space engineering, or in engineering aspects of major works and structures, the mechanical engineer finds professional occupation, either as employee or consultant. His responsibility will generally be for the superintendence of operations and personnel, for the design of products and processes, and may include the administration of enterprises.

The curriculum in Mechanical Engineering provides an analytical training in mathematics and the physical sciences designed as a disciplinary basis for active professional practice. Recognition is given, however, to the purer scientific and philosophical concepts essential to postgraduate study and research.

For the First Year curriculum see Division A, page 21.

SECOND YEAR MECHANICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2420	2	1	2	1
Circuit Theory	717	2	1½	–	–
Design of Machine Elements	356, 357	–	–	2	3
Differential Equations	380	–	–	2	1
Dynamics	351	3	1	–	–
Economics	2720	2	–	2	–
Electrical Measurements	718	–	–	2	1½
Materials Science	834	2	–	2	1½
Mechanics of Materials	107, 104	3	–	1	3
Probability and Statistics	2422	2	1	–	–
Theory of Machines	358	–	–	2	3
Practical Experience	20	–	–	–	–

THIRD YEAR MECHANICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Dynamics Measurements Laboratory	362	–	3	–	3
Engineering Design	363, 364	–	–	2	3
Engineering Mathematics I	386	3	1	3	1
Electric Machines	747	–	–	2	3
Electronics	743	2	3	–	–
Fluid Mechanics I	334	2	–	2	3
Heat Engineering	308	2	–	–	–
Heat Engineering Laboratory I	310	–	3	–	3
Systems Dynamics	360	1	–	1	–
Engineering Thermodynamics	309	2	–	2	–
Vibrations	361	2	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

FOURTH YEAR MECHANICAL ENGINEERING

Applied Mathematics in Engineering	390	1	3	2	3
Elementary Control Theory	391, 392	1	–	1	3
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Heat Engineering Laboratory	324	–	3	–	4½
Hydraulics	344, 345	2	3	2	4½
Industrial Management	396	1	–	–	–
Machine Design	373, 374	2	3	2	4½
Philosophy and Science	2040	2	–	–	–
Practical Experience	20	–	–	–	–
Structural Engineering	126, 127	2	3	–	–
Thermal Energy Conversion I	322	2	–	2	–
Thermal Energy Conversion II	323	–	–	2	–
Thesis	40	–	1	–	1

Industrial Engineering

STAFF OF THE DEPARTMENT

Professor and Chairman of the Department:
B. Bernholtz, M.A., PH.D.(CAL. TECH.)

Associate Professor and Assistant Department Chairman:
R. W. P. Anderson, M.A.SC.

Professors:
J. W. Abrams, A.B., PH.D.(CALIF.)
P. J. Foley, M.A.(GLASGOW)
A. Porter, M.SC., PH.D.(MANCH.)

Associate Professors:
S. H. Cohn, M.A.
T. A. Lambe, B.A.SC.(U.B.C.), M.SC.(STAN.), PH.D.(STAN.)
J. G. C. Templeton, B.A., M.A.(PRINC.), PH.D.(PRINC.)

Assistant Professors:
S. M. Abdelmessih, B.SC., S.M., PH.D.
J. A. Buzacott, B.SC., B.E., M.SC., PH.D.(BIRMINGHAM)
A. A. Cunningham, M.A.
M. M. Posner, B.A.SC., PH.D.

Lecturers:
H. W. Jackman, M.A.SC.
A. K. Mackworth, B.A.SC., M.A.(HARVARD)

INDUSTRIAL ENGINEERING

Course 4

The modern view of Industrial Engineering is that of a field concerned with the analysis, design improvement and operation of integrated systems of men, materials and equipment. This concept crystallized when it became clear that certain modern technical fields,

including operations research, control theory, computer science, probability and statistics, systems theory and human factors engineering, constituted a body of knowledge particularly useful in the operation and management of modern business, industry and government.

As a logical outcome of this development, the course in Industrial Engineering was established in 1958 to provide graduates in engineering specializing in the theory and practice of these subjects. This specialization rests upon a substantial foundation in science and mathematics, in fundamental engineering disciplines including fluid mechanics, applied thermodynamics, electric science, mechanics of materials, materials science and automation, and in such subjects as economics, organizational structure, financial control and industrial psychology.

For the First Year curriculum see Division A, page 21.

SECOND YEAR INDUSTRIAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2420	2	–	2	–
Computer Programming I	422	1	1½	1	1½
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Elements of Industrial Engineering	414	2	–	2	–
Materials Science	834	2	–	2	3
Mechanics of Materials	102, 104	2	3	2	–
Probability and Statistics I	2423, 2424	2	2	2	2
Practical Experience	20	–	–	–	–

THIRD YEAR INDUSTRIAL ENGINEERING

Accounting	2734	2	–	2	–
Computer Programming II	423	1	1½	1	1½
Differential Equations	2432	2	–	2	–
Control Engineering	394, 395	2	3	2	3
Engineering Thermodynamics	311, 312	–	–	2	3
Fluid Mechanics	337	2	3	–	–
Numerical Analysis	2433, 2434	2	3	2	3
Probability and Statistics II	2430, 2431	1	1½	1	1½
Practical Experience	20	–	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

FOURTH YEAR INDUSTRIAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Automatic Control of Processes	415	2	–	2	–
Engineering Law	3440	1	–	–	–
English	2140	1	–	1	–
Human Factors Engineering	416	3	–	3	–
Industrial Engineering Seminar	417	–	2	–	2
Management Science	418	2	–	2	–
Operations Research	419	2	3	4	3
Philosophy and Science	2040	2	–	–	–
Systems Theories	420	2	3	2	3
Thesis Project	40, 421	–	6	–	6

Engineering Science

MEMBERS OF THE DIVISION

Chairman of the Division:
B. Etkin, M.A.SC., F.C.A.S.I. (Professor of Aerospace Engineering).

Members of the Division:
P. P. Biringer, DIP. ING. (BUD.), M.SC. (STOCKHOLM), PH.D. (Professor of Electrical Engineering)
G. B. Craig, M.A.SC., PH.D. (Professor of Metallurgy and Materials Science)
W. F. Graydon, M.A.SC., PH.D. (MINN.), (Professor of Chemical Engineering)
T. E. Hull, M.A., PH.D. (Professor of Mathematics and Computer Science)
G. D. Scott, M.A., PH.D. (Professor of Physics)
J. Vande Vegte, DIP. ING. (DELFT), M.A.SC., PH.D. (Professor of Mechanical Engineering)

ENGINEERING SCIENCE

Course 5

The Engineering Science course is designed for students whose primary interest is in the applications of science to modern technology, and who wish to prepare themselves for careers in research, development or teaching. The undergraduate course provides excellent preparation for post-graduate work in a wide range of specialities in Engineering, Science and Mathematics, and the majority of graduates from this course do proceed to graduate study. Students who graduate from the course and do not continue their studies are nevertheless well qualified to fill a variety of positions in Industry and Government.

The courses offered are of a high standard, so that only students with better-than-average ability in mathematics and science can expect to succeed in them. For this reason, admission is granted only to those who attain an average of at least 70% in the Ontario Grade XIII or its equivalent (see p. 9). The First Year of the Course

may not be repeated without the special permission of the Council of the Faculty, and continuation into the second year is restricted to those whose weighted average grade in first year is 66% or higher. Those who achieve the general promotion average of 60% in the first year may continue without condition into the second year of any other course in the Faculty.

The curricula for the first two years of the course are common for all students. In the third and fourth years, there are a few common subjects, and considerable latitude in the selection of the remainder. There are available eight carefully planned *options*,† each of which provides a specialized preparation for a particular branch of applied science. In addition students have the opportunity not to enroll in any one of these options, but to take an *elective program*, as outlined below.

For the First Year curriculum see Division B, page 22.

SECOND YEAR ENGINEERING SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2425	3	2	3	2
Economics	2720	2	–	2	–
Electric Circuits	715, 716	2	1½	2	1½
Mechanics of Materials	103	1	–	1	–
Numerical Methods	2429	3	2	–	–
Physical Chemistry	608, 609	2	1½	2	1½
Physics	2521, 2522	3	3	3	3
Probability and Statistics	2427	–	–	3	2

Each student is asked to indicate before the end of Second Year his intended course of study in the Third and Fourth Years, but such indication is not binding. He may elect to enroll in one of the options listed, or alternatively to select a program that does not conform to any one of them. In the latter case, there are three conditions to be met.

(i) The program shall average from 18 to 20 load units over the year. One unit is 1 hour lecture per week or 3 hours laboratory per week.

(ii) The selection of courses is subject to the constraints imposed by the current timetable of lectures and laboratories, and by prerequisites. Information about third year prerequisites for fourth year courses is available in the Engineering Science office.

(iii) The program must be discussed with, and approved by a member of the staff of the Division of Engineering Science.

† For further information about the Aerospace Option, see page 56.

THIRD YEAR ENGINEERING SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
COMMON SUBJECTS					
Differential Equations	2438	2	–	2	–
Theory of Functions	2437	2	–	2	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				
OPTION 5A, *Aerospace*					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	–	–	4	–
Physical Electronics	739, 738	2	–	2	3
Mechanics of Structures	1034, 1035	2	1½	2	3
Fluid Mechanics	1028, 1029	2	3	1	1½
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	2	–	–	–
OPTION 5C, *Chemical*					
Atomic & Molecular Structure	2631	2	–	2	–
Chem. Eng. Rate Processes	641	–	–	3	–
Chem. Eng. Thermodynamics	640	2	–	2	–
Chem. Eng. Problems & Lab	642	–	9	–	7½
Electronics	740, 741	2	–	2	1½
Fluid Mechanics	338	2	3	–	–
Synthetic Chemistry	626	2	–	2	–
OPTION 5CS, *Computer Science*					
Advanced Programming I	3338	3	6	–	–
Advanced Programming II	3339	–	–	3	6
Atomic Structure and Quantum Physics	2533	–	–	4	–
Circuit Analysis	742	2	–	2	–
Physical Electronics	739, 738	2	–	2	3
Statistical Physics	2531	2	–	–	–
OPTION 5E, *Electrical*					
Advanced Mechanics	1030	2	–	2	–
Atomic Structure and Quantum Physics	2533	–	–	4	–
Circuit Analysis	742	2	–	2	–

THIRD YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Electromagnetic Fields	754	1	1	1	1
Physical Electronics	739, 738	2	–	2	3
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531	2	–	–	–
OPTION 5G, *Geophysics*					
Advanced Mechanics	1030	2	–	2	–
Astronomy and Geophysics	2537, 2538	2	2	2	2
Atomic Structure and Quantum Physics	2533	–	–	4	–
Electronics	740, 741	2	–	2	1½
Geophysics Laboratory	2539	–	3	–	–
Physics Laboratory	2532	–	3	–	3
Physics of Solids and Fluids	2534	1	–	1	–
Statistical Physics	2531	2	–	–	–
OPTION 5M, *Materials Science*					
Advanced Mechanics	1030	2	–	2	–
Atomic and Molecular Structure	2631	2	–	2	–
Chemical Metallurgy	802, 829	2	–	–	3
Metallurgical Thermodynamics	830, 831	1	2	1	2
Materials Science	832	2	–	2	–
Physics of Metals	821, 822	2	6	2	3
Physics of Solids and Fluids	2534	1	–	1	–
X-ray Crystallography	2901	–	2	–	2
OPTION 5NT, *Nuclear and Thermal Power*					
Advanced Mechanics	1030	2	–	2	–
Applied Elasticity	365, 366	1	3	1	3
Atomic Structure and Quantum Physics	2533	–	–	4	–
Fluid Mechanics	340	2	3	2	3
Heat Engineering	313, 314	1	3	1	3
Physics Laboratory	2532	–	3	–	3
Statistical Physics	2531	2	–	–	–
OPTION 5P, *Physics*					
Advanced Mechanics	1030	2	–	2	–

THIRD YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Atomic Structure and Quantum Physics	2533	–	–	4	–
Electromagnetic Fields	754	1	1	1	1
Physical Electronics	739, 738	2	–	2	3
Physics Laboratory	2532	–	3	–	3
Physics of Solids & Fluids	2534	1	–	1	–
Statistical Physics	2531	2	–	–	–
And one of:					
Applied Elasticity	365, 366	1	3	1	3
Circuit Analysis	742	2	–	2	–

FOURTH YEAR ENGINEERING SCIENCE

COMMON SUBJECTS					
Differential Equations of Mathematical Physics	2445	2	–	2	–
Philosophy and Science	2040	2	–	–	–
English	2140	1	–	1	–
Thesis	40	–	–	–	–
OPTION 5A, *Aerospace*					
Aerodynamics	1040, 1041	2	1½	2	1½
Electronic Circuits	778, 769	2	–	1	3
Engineering Design	1043	–	6	–	3
Gasdynamics	1048, 1049	2	1½	2	3
Plasmadynamics	1046	2	–	2	–
Transport Phenomena	1050	–	–	2	–
And one of:					
Physics and Mechanics of Solids	1044, 1045	2	1½	2	3
Physics of Radiating Gases	1042, 1047	2	1½	2	1½
System Dynamics	766, 773	2	1½	2	1½
OPTION 5C, *Chemical*					
Chem. Eng. Design	666	2	6	2	6
Chem. Eng. Laboratory	652	–	9	–	–
Thermodynamics of Chemical Systems	665	3	–	–	–
Dynamics of Chemical Systems	667	–	–	3	–
Mass Transfer	650	2	–	2	–
Organic Chemistry	660, 661	2	–	1	6

FOURTH YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Process Dynamics	664	2	–	2	3
OPTION 5CS, *Computer Science*					
Electronic Circuits	778, 769	2	–	1	3
Information Systems I	782	2	–	1	–
Information Systems II	786, 783	–	–	2	3
Mathematical Foundations of Computer Science	3340	2	–	2	–
Numerical Solution of Partial Differential Equations	2440	2	–	2	–
Switching Theory	760	2	1	–	–
Techniques of Optimization	787	2	3	2	3
OPTION 5E, *Electrical*					
Energy Conversion Processes	788, 789	2	1½	2	1½
Electronic Circuits	778, 769	2	–	1	3
Information Systems I	782	2	–	1	–
Information Systems II	786, 783	–	–	2	3
Quantum Mechanics	2545	2	–	2	–
System Dynamics	766, 773	2	1½	2	1½
Wave Theory	790, 791	2	3	3	–
OPTION 5G, *Geophysics*					
Control Systems	398, 399	1	–	2	3
Geophysics Laboratory	2573	–	6	–	9
Geophysical Methods	2561	2	–	2	–
Physics of the Earth	2570	2	–	2	–
Geology	2903	2	2	2	2
And one of:					
Atmospheric Physics	2571	2	–	2	–
Solids within the Earth	2572	2	–	2	–
Tectonophysics	2574	2	–	2	–
OPTION 5M, *Materials Science*					
Chemical Metallurgy	805	3	–	3	–
Materials Science Laboratory	827	–	12	–	12
Materials Science Seminar	826	–	3	–	3
Physics of Metals	823, 824	4	3	4	3
And one of:					
Physical Electronics	738, 739	2	–	2	3
Materials Science Laboratory	827	–	3	–	3

FOURTH YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
OPTION 5NT, *Nuclear and Thermal Power*					
Control Systems	398, 399	1	–	2	3
Heat Transfer	328	–	–	2	–
Nuclear and High Energy Physics	2544	–	–	4	–
Nuclear Engineering	670, 671	2	3	2	3
Physics Laboratory	2542	–	3	–	3
Thermal Energy Conversion	331, 332	3	3	3	3
Computational Methods	393	1	3	1	3
OPTION 5P, *Physics*					
Electronic Circuits	778, 769	2	–	1	3
Physics Laboratory	2542	–	6	–	6
Quantum Mechanics	2545	2	–	2	–
Wave Theory	790	2	–	3	–
And any two of:					
Electromagnetic Radiation and Matter	2541	4	–	–	–
Molecular Physics and Statistical Mechanics	2543	4	–	–	–
Nuclear and High Energy Physics	2544	–	–	4	–
Relativity Theory	2547	2	–	2	–
Solid State Physics	2546	–	–	4	–

Chemical Engineering and Applied Chemistry

STAFF OF THE DEPARTMENT

Professor and Head of the Department:

J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.)

Associate Professor and Assistant Head of the Department:

J. W. Smith, M.A.SC.(U.B.C.), PH.D.(LOND.)

Professors:

D. G. Andrews, M.A.(CANTAB.) (*Nuclear Engineering*)
W. H. Burgess, B.CH.E., M.F.S., PH.D.(CORN.)
W. F. Graydon, M.A.SC., PH.D.(MINN.)
R. E. Jervis, M.A., PH.D.
W. G. MacElhinney, M.A.SC.
R. W. Missen, M.SC.(QU.), PH.D.(CANTAB.)
W. H. Rapson, M.A.SC., PH.D.
I. H. Spinner, M.A.SC., PH.D.
O. Trass, B.S.E.(PRINC.), SC.D.(M.I.T.)
M. Wayman, M.A., PH.D.
H. L. Williams, B.A., M.SC.(WESTERN), PH.D.(MCGILL)

Associate Professors:

D. Basmadjian, DIP. ING. CHEM.(ZURICH), M.A.SC., PH.D.
M. E. Charles, B.SC.(LOND.), M.SC., PH.D.(ALTA.)
W. A. M. Hewer, B.A.SC. (*Mining Engineering*)
R. L. Hummel, B.S.(PURDUE), PH.D.(IOWA)
R. Luus, M.A.SC., A.M., PH.D.(PRINCETON)
S. Sandler, M.A.SC.
R. T. Woodhams, M.SC.(U.W.O.), PH.D.(BROOKLYN) (*Materials Science*)

Assistant Professors:
D. Barham, B.SC.ENG., D.I.C., PH.D.(LOND.)
C. E. Chaffey, B.SC., PH.D.(MCGILL) (*Materials Science*)
D. Mackay, B.SC., PH.D.(GLASGOW)

Lecturers:
C. C. Barnes,B.SC.(QU.)
J. Binkiewicz, DIP. CHEM. ENG.(LWOW)
Z. May, DIP. ING. CHEM.(WARSAW)
Miss M. J. Phillips, B.A.SC., M.A.(BRYN. MAWR.), PH.D.(J.H.U.)
A. Rozeiu, DIP. CHEM. ENG.(BUCHAREST)

Special Lecturer:
C. P. Brockett, B.SC.(M.I.T.)

CHEMICAL ENGINEERING

Course 6

The chemical engineer is concerned with the development and operation of processes by means of which matter is chemically altered to a more useful form, and in the design, construction, operation and management of plant in which to effect such changes. In addition to such obviously chemical processes as those encountered in the petroleum refining and petro-chemical industry, a great variety of industrial processes involve chemistry and require the abilities of the chemical engineer. In order to equip a student to start his professional career as a chemical engineer, the undergraduate course is intended to provide him with training in the principles of the major divisions of chemistry and chemical engineering, together with the essentials of other engineering subjects.

In the second term of the final year, certain elective subjects and the topic chosen for the thesis allow the student to specialize according to his interests and abilities. The thesis serves as an introduction to research, and its nature may vary widely depending on the interests of the staff and students. It may, for example, be concerned with an experimental laboratory investigation, the design of a process, or a computer study of a chemical system.

For the First Year curriculum see Division A, page 21.

SECOND YEAR CHEMICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Analytical Chemistry	615, 614	2	9	–	–
Analytical Chemistry and Computation Laboratory	613	–	–	–	–
Calculus	2420	2	1	2	1
Chemical Engineering Science Laboratory	619	–	–	–	7½
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Introduction to Mass and Heat Transfer	631	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	102	2	–	2	–
Physical Chemistry	622	2	–	2	–
Process Calculations	620	–	3	–	3
Practical Experience	20	–	–	–	–

THIRD YEAR CHEMICAL ENGINEERING

Applied Mathematics	633	1	1	1	1
Chemical Engineering Thermodynamics	640	2	2	2	2
Chemical Laboratory	627	–	6	–	6
Reaction Kinetics	625	1	–	1	–
Fluid Mechanics	339, 632	2	3	2	–
Industrial Chemistry	630	2	–	1	–
Mass Transfer Operations	650	2	1	2	1
Organic Chemistry	628, 629	2	6	2	9
Practical Experience	20	–	–	–	1
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

FOURTH YEAR CHEMICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemical Engineering Thermodynamics and Kinetics	655	2	–	2	–
Chemical Engineering Laboratory	652	–	9	–	–
Chemical Plant Design	651	2	6	–	–
English	2140	1	–	1	–
Organic Chemistry	654	2	–	2	–
Philosophy and Science	2040	2	–	–	–
Practical Experience	20	–	–	–	–
Process Dynamics	653	2	3	–	–
Public Speaking	656	–	–	–	2
Thesis	40	–	1	–	18
And one of:					
Advanced Separation Processes	669	–	–	2	–
Applied Nuclear Chemistry	668				
Instrumental Methods	663				
Process Control	662				

Electrical Engineering

STAFF OF THE DEPARTMENT

Professor and Head of the Department:
G. R. Slemon, M.A.SC., D.I.C.(IMP. COLL), PH.D.(LOND.)

Associate Professor and Assistant Head of the Department:
W. Janischewskyj, B.A.SC., M.A.SC.

Professors:
P. P. Biringer, DIP. ING.(BUD.), M.SC.(STOCKHOLM), PH.D.
J. M. Ham, B.A.SC., S.M.(M.I.T.), SC.D.(M.I.T.)
N. F. Moody, B.SC.(SASK.)
G. Sinclair, B.SC.(ALTA), M.SC.(ALTA.), PH.D.(OHIO STATE)
J. L. Yen, B.SC.(CHIAO TUNG), M.A.SC., PH.D.

Visiting Professor:
J. A. Roberts, B.SC.(SYDNEY), M.SC.(SYDNEY), PH.D.(CAMBRIDGE)

Associate Professors:
K. G. Balmain, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
P. E. Burke, B.E.(N.S. TECH.), M.A.SC.
R. S. C. Cobbold, B.SC.(LOND.), M.SC.(SASK.), PH.D.(SASK.)
E. J. Davison, A.R.C.T., B.A.SC., M.A., PH.D.(CAMB.)
G. W. Dick, B.A.SC., M.A.SC., PH.D.
S. Dmitrevsky, B.A.SC., PH.D.(HARV.)
V. L. Henderson, B.A.SC., A.M.(MICH.)
K. Iizuka, B.S.(KYOTO), M.S.(KYOTO), PH.D.(HARV.)
A. J. Kravetz, B.SC.(ALTA.), M.A.SC.
G. R. Lang, B.SC.(U.W.O.)
E. S. Lee, B.ENG.(MCG.), M.ENG.(MCG.), PH.D.
E. Llewellyn Thomas, B.SC.(LOND.), M.D., C.M.(MCG.)
I. McCausland, B.SC.(Q.U. BELFAST), M.SC.(Q.U. BELFAST), PH.D.(TOR., CANTAB)

S. D. T. Robertson, B.SC.(QUEEN'S), D.I.C.(IMP. COLL.), M.A.SC., PH.D.
H. W. Smith, B.A.SC., SC.D.(M.I.T.)
K. C. Smith, B.A.SC., M.A.SC., PH.D.
A. Straughen, B.SC.(LOND.), M.A.SC.

Assistant Professors:
P. I. P. Boulton, M.A.SC., D.I.C.(IMP. COLL.), PH.D.
M. G. Currie, B.A.SC.
I. R. Dalton, B.A.SC., M.S.(NORTHWEST)
S. B. Dewan, B.SC.(PANJAB), M.E.(ROURKEE), M.A.SC., PH.D.
V. C. Hamacher, B.A.SC.(WATERLOO), M.SC.(QUEEN'S)
H. Kunov, M.SC.(DENMARK)
H. O'Beirne, B.A.(CAMB.), M.A.SC.
I. H. Rowe, B.A.SC., M.A.SC., PH.D.(LOND.)
C. A. T. Salama, B.A.SC.(UBC), M.A.SC.(UBC), PH.D.(UBC)
M. Sablatash, B.SC.(MAN.), M.SC.(MAN.)
R. S. Segsworth, B.A.SC.
S. Zukotynski, M.A.SC.(WARSAW), PH.D.(WARSAW)

Lecturers:
R. T. H. Alden, B.A.SC., M.A.SC.
Z. G. Vranesic, B.A.SC., M.A.SC.

ELECTRICAL ENGINEERING

Course 7

Electrical Engineers are concerned with all things electrical; but such a simple statement fails to convey any real notion of the great variety of activity in which they are engaged, the many aspects of their concern, or the nature of the education that they require.

Electrical engineers are, of course, still involved in the traditional areas – the generation, transmission and utilization of electrical power and the communication of information – but they are being faced daily with situations not envisaged even a few years ago. They are searching continuously for new approaches that may be better suited to future needs, as for example, magnetodydrodynamic generation, microelectronics and satellite communication. There is a growing demand for sophisticated electrical sensing and control equipment for a wide variety of non-electrical processes, and for electronic computers capable of the rapid processing of large volumes of information and the solving of increasingly complex problems.

Within any of these areas the electrical engineer may be engaged in research, development, design, manufacture, operation or management. He may have to assist other enginers and scientists in widely differing fields by supplying them with techniques or insights unfamiliar to them, as for example, in the developing field of bio-medical engineering, or he may have to coordinate the application of many technologies in a single project. In addition to all of this, he must accept considerable responsibility in community affairs.

It is obvious then, from the wide range of his possible involvement, that the electrical engineer needs a professional education of great breadth and depth. In the undergraduate course, stress is laid on building a solid foundation. The time limitation requires that only material which is essential can be included; much that might be immediately helpful must be omitted to make room for that which will still be relevant for several years. On this base, the graduate will have to build his continuing education.

The electrical engineer makes extensive use of mathematical techniques and concepts; mathematics is thus of the utmost importance and a large portion of the course is devoted to it. Fundamental subjects such as mechanics, electrical physics, chemistry and thermodynamics get considerable attention in the early years. The basic electrical engineering subjects (electromagnetic field theory, electronics, machine principles and circuit theory) follow these, with expansion and some specialization in the final year. Also included are a few non-technical subjects of importance.

Electrical engineering is characterized by the relatively large proportion of its graduates who proceed to post-graduate study to get advanced training in a particular area. Information on this may be obtained from the calendar and other publications of the School of Graduate Studies.

For the First Year curriculum see Division A, page 21.

SECOND YEAR ELECTRICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Dynamics	352, 353	2	1½	2	1½
Electric Circuits	710	3	2	2	2
Electric and Magnetic Fields	711	2	2	2	2
Electrical Laboratory	713	–	3	–	3
Introductory Electronics	714	–	–	2	1
Programming & Numerical Methods	721	2	–	1	–
Materials Science I	835	2	1½	2	1½
Calculus and Differential Equations	2421	2	2	2	2
Economics	2720	2	–	2	–
Practical Experience	20	–	–	–	–

THIRD YEAR ELECTRICAL ENGINEERING

Physical Electronics	730	2	–	2	–
Applied Mathematics	732	2	2	2	2
Linear System Theory	733	2	2	3	2
Electrical Machinery I	734	2	1	2	1
Electrical Laboratory	735	–	3	–	3
Electronic Circuits I	737	–	–	2	1

THIRD YEAR ELECTRICAL ENGINEERING (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Electronics Laboratory	738	–	–	–	3
Fields and Waves	750	2	2	–	–
Thermodynamics and Statistical Mechanics	751	3	1	–	–
Physics of Metals	819, 820	–	–	2	1½
Practical Experience	20	–	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

FOURTH YEAR ELECTRICAL ENGINEERING

Switching Theory	760	2	1	–	–
Electromagnetic Theory	762	2	1	–	–
Electric Machinery II	763, 764	2	3	–	–
Control Systems	765, 767	2	1½	2	1½
Electronic Circuits II	768, 769	3	3	–	–
Network Theory	772	–	–	2	1
Philosophy and Science	2040	2	–	–	–
English	2140	1	–	1	–
Engineering Law	3440	1	–	–	–
Thesis	40	–	–	–	–
Practical Experience	20	–	–	–	–
and one subject from each of Groups A, B, C and D:					
GROUP A					
Communication Systems	770, 771	–	–	3	3
Electrical Power Systems	779, 780				
GROUP B					
Radiation and Propagation	776	–	–	2	1½
Power Semiconductor Circuits	795				
GROUP C					
Computer and Information Systems	761	–	–	2	1
Quantum Electronics	784				
GROUP D					
Acoustics	792	–	–	2	1½
Illumination	794				
Biomedical Engineering	796				

Metallurgy and Materials Science

STAFF OF THE DEPARTMENT

Professor and Head of the Department:
L. M. Pidgeon, M.B.E., B.SC.(OXON.), PH.D.(MCG.), F.R.S.C.

Professors:
K. T. Aust, M.A.SC., PH.D.
G. B. Craig, M.A.SC., PH.D.
S. N. Flengas, B.SC.(ATHENS), D.I.C.(LOND), PH.D., D.SC.(LOND.), F.C.I.C.
H. U. Ross, C.D., M.SC.(MCG.)
J. W. Rutter, M.A., PH.D.

Associate Professors:
Mrs. U. Martius Franklin, PH.D.(BERLIN)
B. Ramaswami, B.SC., D.I.I.SC., M.A., PH.D.(HARVARD)
J. M. Toguri, M.A.SC., PH.D.

Assistant Professors:
W. A. Miller, PH.D.(MCG.)
R. S. Segsworth, B.A.SC.
G. C. Weatherly, PH.D.(CANTAB.)

Special Lecturers
J. Basterfield, PH.D.(BIRM.)
A. E. El-Mehairy, PH.D.(LOND.)

METALLURGY AND MATERIALS SCIENCE

Course 8

"Metallurgy and Materials Science" is the study of the production, structure, and properties of the engineering materials used in structures, machines and devices.

Modern technology makes increasingly severe demands upon both metallic and non-metallic solids; in fact, it is difficult to think of an engineering project, the basic

limitations of which do not reside in the materials which are available. For example, aerospace travel requires materials capable of withstanding extremes of heat, cold and pressure; the utilization of nuclear energy is limited only by materials which can withstand the effects of radiation; the transistor and the computer depend upon materials having special electrical and magnetic properties. As industry expands, the metallurgist or materials engineer is being called upon to play an increasingly important role in the economy.

The course is designed to place primary emphasis upon the fundamental principles which underlie the chemical, physical and mechanical properties of solids. In the fourth year, each student is assigned an experimental problem involving original work and, where possible, this is related to the actual research in progress in the department. The student is, therefore, introduced to the methods of research.

The department is equipped with modern facilities for the study of the structure and properties of materials. This equipment includes x-ray diffraction units, an electron beam microprobe analyzer, an electron microscope, several optical metallographs, materials preparation and testing equipment, facilities for the production and measurement of high temperatures, high vacuum equipment, etc.

For the First Year curriculum see Division A, page 21.

SECOND YEAR METALLURGY AND MATERIALS SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Analytical Chemistry	2624	1	3	1	3
Calculus	2420	2	1	2	1
Economics	2720	2	–	2	–
Electrical Engineering	719, 720	2	3	2	3
Inorganic Chemistry	617	1	–	2	–
Materials Science	832	2	–	2	–
Mechanics of Materials	105, 104	2	–	2	3
Physical Chemistry	801	2	–	1	–
Principles of Metallography	816	1	3	–	–
Probability and Statistics	2423, 2424	2	2	2	2
Practical Experience	20	–	–	–	–

THIRD YEAR METALLURGY AND MATERIALS SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemical Metallurgy	802, 803	2	3	–	6
Differential Equations	2432	2	–	2	–
Engineering Data Processing	3331, 3332	–	–	2	3
Fluid Flow and Heat Transfer	341	2	–	2	3
Materials Processing	833	2	–	1	–
Physics of Metals	821, 822	2	6	2	3
Thermodynamics in Metallurgy	810, 812	2	4	2	4
X-ray Crystallography	2901	–	2	–	2
Practical Experience	20	–	–	–	–
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

FOURTH YEAR METALLURGY AND MATERIALS SCIENCE

Chemical Metallurgy	805, 806	3	6	3	–
English	2140	1	–	1	–
Materials Science Seminar	826	–	3	–	3
Metallurgical Problems Laboratory	814	–	2	–	2
Philosophy and Science	2040	2	–	–	–
Physics of Metals	823, 824	4	3	4	3
Physical Chemistry of Materials	813	–	–	2	–
Reaction Kinetics	836	2	–	–	–
Thesis	40	–	6	–	9
Practical Experience	20	–	–	–	–

Geological Engineering

The course in Geological Engineering is an interfaculty course, the specialized core of which is provided by the Department of Geology (Faculty of Arts and Science) with assistance from several departments of the Faculty of Applied Science and Engineering. It is administered by a Course Committee the current members of which are:

E. W. Nuffield, B.A.(B.C.), PH.D., F.R.C.S., *Chairman; Professor and Chairman, Department of Geology.*

W. D. Baines, B.SC.(ALTA.)., M.SC., PH.D.(IOWA); *Professor of Mechanical Engineering.*

J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.), *Professor and Head, Department of Chemical Engineering.*

J. B. Currie, B.A.(MCM.), M.A., PH.D., *Professor of Geology*

T. C. Kenney, B.ENG.(MCG.), D.I.C.(IMP.), M.SC.(LOND.), PH.D.(LOND.), *Professor and Chairman, Department of Civil Engineering.*

H. R. Rice, B.SC.(QUEENS), *Professor of Mining Engineering*

GEOLOGICAL ENGINEERING

Course 9

Geology is the science of the earth. It includes, in a large sense, all knowledge of the earth – its origin, history, structure, composition and mineral wealth – and the physical, chemical and biological processes that change the earth. It spans a wide range of sciences and requires a thorough grounding in mathematics and the basic science and engineering disciplines to aid in a proper understanding of the subject and its many applications. The various branches of geology include geophysics, which is concerned with the investigation of the earth, particularly its structure and composition, by the methods of experimental physics; geochemistry, which may be defined broadly to include all parts of geology that involve chemical changes; and geobiology which deals with the totality of living things on the earth's surface in geologic time.

The first three years of the course in Geological Engineering provide a broad educa tion in the fundamentals of geology and its associated disciplines. In the fourth yea the course concentrates on the study of Economic Geology – the application of prin ciples and methods of geology in the discovery, examination, evaluation and productio of mineral, fossil fuel and water resources. An option in the last year allows the studer to choose between the subjects Exploration Geophysics (2568, 2569) and Mine Opera tion and Administration (224, 226) thereby emphasizing either the search for or th development of mineral deposits.

Graduation from this course leads to employment in mineral and petroleum explora tion and development. Graduates are prepared for advanced study towards the M.A.S and Ph.D. degrees in a number of branches of geology including Economic Geolog Geochemistry, Structural Geology and Applied Geophysics.

For the First Year curriculum see Division A, page 21.

SECOND YEAR GEOLOGICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2420	2	1	2	1
Economics	2720	2	–	2	–
Inorganic Chemistry	617	1	–	2	–
Mechanics of Materials	106, 104	2	–	1	1½
Mineralogy	2921	2	5	2	5
Mining	195	1	–	1	2
Physical Chemistry	622	2	–	2	–
Principles of Geology	2920	2	2	2	2
Surveying	155, 156	1	1½	1	1½
Practical Experience	20	–	–	–	–

THIRD YEAR GEOLOGICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Geological Field Trips	2937	–	–	–	–
Metallurgy	804	–	–	2	–
Mineral Identification Laboratory	2934	–	2	–	2
Petroleum Geology, Ground Water	2933	2	3	2	3
Petrology	2930	2	2	2	2
Photogrammetry	162, 163	2	3	–	–
Practical Experience	20	–	–	–	–
Stratigraphy and Sedimentation	2931	2	2	2	2
Structural Geology	2932	1	3	1	3
Survey Camp	158	–	–	–	–
Theory of Phase Equilibria	2935	2	–	2	–
One of:					
*Differential Equations	2432	2	–	2	–
Mining Technology	196				
And one of:					
History	2330 or 2332	2	–	2	–
Political Science	2730				

*Prerequisite for Exploration Geophysics 2568, 2569 in the Fourth Year.

FOURTH YEAR GEOLOGICAL ENGINEERING

English Literature	2140	1	–	1	–
Exploration Geochemistry	2943	1	3	1	3
Geological Data Analysis	2942	2	2	2	2
Geological Field Trips	2947	–	–	–	–
Laboratory Research	2945	–	3	–	3
*Geology Field Camp	2946	–	–	–	–
Metallurgy	808	1	–	1	–
Mineral Deposits	2940, 2941	2	3	2	3
Mineral Economics	2944	2	–	1	3
Philosophy and Science	2040	2	–	–	–
Thesis	40	–	3	–	3
And one of:					
Exploration Geophysics	2568, 2569	2	3	2	3
Mining	197, 198	2	3	2	3

*Immediately following the Annual Examinations of the Third Year.

TEACHING STAFF OF THE INSTITUTE FOR AEROSPACE STUDIES

Professor and Director of the Institute:

G. N. Patterson, B.SC.(ALTA.), M.A., PH.D., LL.D., D.SC., F.R.AE.S., F.C.A.S.I., F.A.I.A.A., F.R.S.C., F.A.A.A.S.

Professors:

J. H. DeLeeuw, DIP. ING.(DELFT), M.S. in A.E.(GEORGIA TECH.), PH.D., F.C.A.S.I.

B. Etkin, B.A.SC., M.A.SC., F.C.A.S.I.

J. B. French, B.A.SC., M.SC.(BIRMINGHAM), PH.D.

I. I. Glass, B.A.SC., M.A.SC., PH.D., F.A.P.S., F.A.A.A.S., F.C.A.S.I.

H. S. Ribner, B.S.(CAL. TECH.), M.S.(WASH.), PH.D.(WASH.), F.A.P.S., F.A.S.A., F.C.A.S.I.

Associate Professors:

A. J. Howsmon, B.S.M.E.(PURDUE), M.S.(PURDUE), PH.D.(PURDUE)

G. K. Korbacher, DIP. ING.(BERLIN), PH.D.(BRAUNSCHWEIG)

R. C. Tennyson, B.A.SC., M.A.SC., PH.D.

S. J. Townsend, B.A.(SASK.), M.A.(SASK.), PH.D.

Assistant Professors:

W. T. Chu, B.A.SC.(U.B.C.), M.A.SC., PH.D.

P. C. Hughes, B.A.SC., M.A.SC., PH.D.

R. M. Measures, B.SC., A.R.C.S., D.I.C., PH.D.(LOND.)

P. A. Sullivan, B.E., M.E.(N.S.W.), D.I.C., PH.D.(LOND.)

Lecturer:

L. D. Reid, B.A.SC., M.A.SC.

Special Lecturer:

R. D. Hiscocks, B.A.SC., M.B.E., F.C.A.S.I.

AEROSPACE STUDIES

A five-year program of study is offered to prepare the student for a career in the aerospace field. It includes the following elements: (*a*) an introduction to the fundamentals of mathematics, physics, and chemistry, (*b*) an introduction to aerodynamics, instrumentation, propulsion, structures and design, and (*c*) an advanced treatment of the subjects required for modern design and research in aerospace science and engineering such as hypersonic aerodynamics, flight dynamics, and space propulsion. Under (*a*) and (*b*) the student's training is necessarily broad and basic. The more advanced knowledge needed for the research, development, and design relevant to new aircraft and spacecraft is provided under (*c*) and is of particular significance. Parts (*a*) and (*b*) are provided in a four-year undergraduate course, but the final intensive training under (*c*) is left for a postgraduate (fifth) year.

The program of study that leads to status as a well-qualified aerospace engineer has been established in two parts as follows:

(i) *Undergraduate Course.* The student registers in the course in Engineering Science, subject to the entrance requirements given on page 9 of this Calendar. This course provides the requisite training in the fundamental sciences (see (*a*) above). The advanced subjects contained in the Aerospace option given in the third and fourth years are taught by the staff of the Institute for Aerospace Studies (see (*b*) above). The student will receive the degree of Bachelor of Applied Science upon completion of this part of the program.

(ii) *Graduate Course.* If the student's academic record in the undergraduate program meets the requirements for admission to the School of Graduate Studies, he may enter the fifth year of the program as a candidate for the M.A.Sc. or M.Eng. degree in the (graduate) department of Aerospace Studies. Details of entrance regulations and courses of study are given in the Calendar of the School of Graduate Studies. The facilities of the Institute for Aerospace Studies are available to the student for research or project work. For details of research projects, assistantships, scholarships and demonstratorships, students should consult the Annual Bulletin of the Institute.

It should be noted that a student who has graduated in another branch of engineering and who desires to qualify as an aerospace engineer may proceed directly with (ii) above, but in this case the course leading to the M.A.Sc. or M.Eng. degree must be arranged so that deficiencies in his undergraduate training are made up.

The facilities of the Institute are available for further graduate study leading to the Ph.D. Degree.

Outline of Lecture and Laboratory Subjects

On the pages that follow a brief description is given of the lectures and laboratory subjects prescribed in the preceding tables of curriculum. The numbers before the subjects are the reference numbers assigned in the tables; the line following each subject title shows the academic year and course to which the subject is offered and the hours allotted to it in each term.

Where laboratory reports are to be written outside of assigned laboratory hours the maximum number of such reports is indicated in the description of the laboratory course concerned.

11s. ENGINEERING SEMINARS

I – 1, 3, 4, 5, 6, 7, 8, 9 – ½ – ½

A discussion of topics such as: the solution of practical engineering problems; problems arising from courses taken in the First Year; the prosecution of engineering research; or any other topic connected with the student's activities in the University.

The Professorial Staff in Engineering

13s. ENGINEERING APPLICATIONS OF MATHEMATICS

I – 1, 3, 4, 5, 6, 7, 8, 9 – 2 – 1

Problems will be assigned to illustrate engineering applications of mathematics. These problems will be based on the contents of the First Year courses in Chemistry, Physics, and Mathematics, and will be selected to illustrate how the same mathematical models and procedures may enter into diverse applications involving different physical and chemical principles.

The Staff in Engineering

20. PRACTICAL EXPERIENCE

Students in the courses listed below are required to have, before graduation, practical work of a nature acceptable to the department concerned. This may be obtained during the summer vacations but work done before entering the Faculty may also meet the

requirements. Instructions will be issued by the departments concerning the type of work which is acceptable. Practical experience certificate forms may be obtained from the departments and should be returned there when completed.

Course 1	600 hours	Course 7	600 hours
Course 3	600 hours	Course 8	600 hours
Course 4	600 hours	Course 9	600 hours
Course 6	600 hours		

40. THESIS

Every student in the Fourth Year is required to prepare a thesis on an approved subject. Instruction will be issued by the departments concerned.

In some cases written presentation is required, in others oral and written, or it may consist of a research problem followed by a written thesis or report.

DEPARTMENT OF CIVIL ENGINEERING

100s. APPLIED MECHANICS

I – 1, 3, 4, 6, 7, 8, 9 — 2 ¾ 2 ¾

Statics: The principles of statics are applied to the composition and resolution of forces, moments and couples. The equilibrium states of frames and machines are examined. The distributed load concept is applied to finding centroids, centers of mass and fluid pressure. The method of virtual work is applied to systems of rigid bodies and elastic members. Dynamics: Applications of the principles of dynamics are discussed for motion on straight and curved paths. Work, energy, power and momentum concepts are applied to particles, systems of particles and rigid bodies. Simpler applications in relative motion are considered. Throughout statics and dynamics the free body concept is emphasized and vector algebra is used where it is most useful. Textbook: *Mechanics for Engineers; Statics and Dynamics* – Meriam

Staff in Civil and Mechanical Engineering

101. STATICS

I – 5 — 2 – – –

Translational and rotational resultants and equilibrants are discussed together with equivalent force systems in two- and three-dimensional space. Emphasis is placed on systems in equilibrium. Distributed forces, applications to structures, friction, method of virtual work, potential energy and stability of equilibrium considered. Textbook: *Vector Mechanics for Engineers: Statics* – Beer and Johnston.

S. M. Uzumeri

102. MECHANICS OF MATERIALS

II – 4, 6 — 2 – 2 –

In this subject, the fundamental theories of stress and strain are investigated as they

apply to the selection of adequately proportioned materials to carry a given load in such engineering applications as tension, compression torsional, and other members. Textbook: *Engineering Mechanics of Deformable Bodies* – Dyars and Schneider.

K. Meipoom, J. Timusk, R. Tress

103. MECHANICS OF MATERIALS

II – 5 1 – 1 –

Basic relationships between force, stress, strain, and deflection of bodies made of various engineering materials are discussed. Beams, columns, shafts, tension members and pressure vessels are analysed and designed for strength and stiffness. Textbook: *Mechanics of Materials* – Popov.

J. Schwaighofer

104. MECHANICS OF MATERIALS LABORATORY

II – 1, 3, 8 – – – 3

II – 4 – 3 – –

II – 9 – – – 1½

An introduction to testing machines, strain and other measuring devices and standard specifications. The experimental study of some engineering materials and structural members under applied load. No laboratory reports will be required to be written outside the assigned teaching hours.

J. D. Barber, C. E. Helwig, K. Meipoom, R. G. Tress

105. MECHANICS OF MATERIALS

II – 1, 8 2 – 2 –

An introduction to the elastic and inelastic behaviour of solids under various external loading conditions. Strains, stresses and deformations are determined for members subjected to tension, compression, torsion and bending and for pressure vessels by using basic strength and materials theories. Textbook: *Mechanics of Materials* – Popov.

J. D. Barber

106. MECHANICS OF MATERIALS

II – 9 2 – 1 –

The fundamental relations among stress, strain and applied load are worked out for tension, compression, twisting and bending in the elastic and inelastic ranges, for various engineering materials. Buckling phenomena are examined for struts and columns. Numerical applications are done in lectures; and problems are assigned for study. Textbook: *Engineering Mechanics of Deformable Bodies* – Byars and Snyder.

A. C. Davidson

107. MECHANICS OF MATERIALS

II – 3 3 – 1 –

In this subject the following are examined: behavior of materials under applied loading

or deformation; stress-strain relations; simple tension, compression torsion, bending and buckling of engineering components; mechanical properties of materials such as ductility, yielding, fracture; fluctuating stresses, stress concentration and fatigue. Mohr's circle will be used in certain stress and certain strain relationships. Textbook: *Engineering Mechanics of Deformable Bodies* – Byars and Snyder.

A. C. Davidson

110. MECHANICS OF MATERIALS II

III – 1A 2 – 2 –

Cement and concrete technology; an introduction to the design and analysis of reinforced concrete members; behaviour of metals; special topics on bending of beams; failure theories; introduction to experimental stress analysis. Problems and laboratory under Course 113. Textbooks: *Properties of Concrete* – Neville; *Mechanics of Materials* – Popov. Reference book: *Concrete Technology I & II* – D. R. Orchard.

J. Schwaighofer, J. Timusk

111. STRUCTURAL DESIGN I

III – 1 2 – 2 –

An elementary study of the stress analysis and design of structures, structural members, and their details. The work covered includes steel and timber tension members, compression members and flexural members, including plate girders and continuous as well as simple span beams. Welding, riveting and high tension bolting, as methods of connecting structural members, are studied. Design and analysis problems under Course 113. Textbook: *Design of Steel Structures* – Gaylord and Gaylord. Reference books: *Structural Problems* – Young and Morrison. *Plastic Design of Steel Frames* – Beedle. National Building Code of Canada.

M. W. Huggins

112. STRUCTURAL THEORY

III – 1A – – 3 –

The stress analysis of simple span, continuous and cantilever trusses. Influence lines and index stresses. Truss deflections by analytical and graphical methods. Analysis of statically indeterminate trusses, beams and frames by various methods. Problems under Course 113. Textbook: *Structural Analysis* – Jack C. McCormac.

C. F. Morrison

113. STRUCTURAL LABORATORY

III – 1A – 7½ – 6

Problems and laboratory to complement subjects 110 and 112. Study periods of design and analysis to complement subject 111; during the fall term two timber structures and during the spring term one steel structure are designed. The designs are discussed and evaluated. Three hours per week of the above time in the first term will be devoted

to the cements and concrete laboratory; the balance will be on problems and design.

Staff in Civil Engineering

115. STRUCTURAL LABORATORY

III – 1B – 1½ – 3

Design and analysis problems to complement subject 111.

J. Barber

116. REINFORCED CONCRETE I

IV – 1A 2 1½ 2 1

IV – 1C 2 3 2 3

Ultimate and working strength behaviour of Reinforced Concrete members subjected to flexure, axial compression, shear, combined axial compression and flexure, combined flexure and shear, and bond. Relation between research results and current specifications for design of members. Design of simple and continuous beams, one way, two way and flat slabs, columns, retaining walls and footings. Reference books: *Reinforced Concrete Fundamentals* – Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Nilson.

S. M. Uzumeri

117. REINFORCED CONCRETE II

IV – 1A 2 1 2 1

Ultimate design; prestressed concrete; composite design; design of building frames, arches and bridges. Behaviour of reinforced concrete members. Reference books: *Theory & Practice of Reinforced Concrete* – Dunham. *Reinforced Concrete Design* – Sutherland and Reese. *Reinforced Concrete Fundamentals* – Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Nilson.

M. W. Huggins

118. BEHAVIOUR AND DESIGN OF STEEL STRUCTURES

IV – 1A 2 2 2 2

A continuation of Course 111. The behaviour of structural elements and structures is discussed and related to design methods and criteria. Topics include, repeated loading, brittle fracture, welding, connections, buckling, inelastic behaviour, analysis and design of metal structures by ultimate load procedures. Textbooks: *Structural Steel Design* – Beedle *et al. Canadian Institute of Steel Construction* – Steel Construction Series, Books 1, 2, 3.

D. J. L. Kennedy

119. STRUCTURAL THEORY II

IV – 1A 2 2 3 2

Analysis of statically indeterminate structures; influence lines for statically indeter-

minate structures; the use of strain energy, slope deflection, moment distribution, column analogy and Kani methods for the analysis of frameworks; elementary aspects of matrix formulation of the analysis of statically determinate and indeterminate plane structures; an introduction to plate theory.

G. Kani, R. A. Collins

120. THESIS PROJECT AND MECHANICS OF MATERIALS LABORATORY

IV – 1A – 4 – 4

Project and Mechanics of Materials laboratory to supplement courses 116, 117 and 118.

Staff in Civil Engineering

122. STRUCTURAL ENGINEERING II

IV – 1B 2 4½ 2 3

Cements and concrete; design and analysis of reinforced concrete members. Design and analysis problems. In the first term 3 hours per week will be devoted to Cements and Concrete laboratory. Textbook: *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Wilson.

C. E. Helwig

126. STRUCTURAL ENGINEERING

IV – 3 2 – – –

The fundamental principles of Statics and Mechanics of Materials are applied to the design and analysis of structural members and their connections. Problems are worked in class and in the drafting room (Subject 127). Moving loads on simply supported beams; tension, compression and flexural member details. Textbooks: *Design of Steel Structures* – Gaylord & Gaylord; *Essentials of Structural Design – Hoadly.*

J. D. Barber

127. STRUCTURAL ENGINEERING PROBLEMS

IV – 3 – 3 – –

Problems supplementing the work covered in lecture course 126.

J. D. Barber

130. CONSTRUCTION MANAGEMENT

IV – 1 – – 2 –

A study of the management and control of engineering-construction projects. Management is discussed in relation to planning, cost estimating, value prediction, scheduling, bidding and labour relations. Control is maintained through accounting records leading to financial statements. Textbook: *Control and Management of Capital Projects* – J. W. Hackney.

K. A. Selby

135. ENGINEERING GRAPHICS

I – 1, 3, 4, 5, 6, 7, 8, 9 1 3 1 3

An introductory course designed to give the student a foundation in spatial visualization

and an appreciation of the various graphical techniques used in representation and in the solution of engineering problems. The lectures are mainly concerned with descriptive geometry, i.e., with the principles of orthographic, oblique and perspective projection and their use in solving problems involving points, lines and surfaces. In the laboratory, problems are solved in descriptive geometry, engineering drawing, empirical equations, charts and graphs. Both instrument and freehand techniques are used. Textbooks: *Graphic Science* – French and Vierck, 2nd edition; *Graphic Science Problems* – Vierck and Hang, 2nd edition.

H. R. Frizzle, C. A. Wrenshall, V. P. Borecky, W. E. Carswell

138. ENGINEERING GRAPHICS

II – 1 – 4½ – 4

Problems in descriptive and projective geometry, nomography, graphical calculus. Graphs and empirical equations. Structural drawing. Plotting of original surveys. Textbook: *Engineering Drawing* – French and Vierck, 10th edition.

C. A. Wrenshall, V. P. Borecky

139. ENGINEERING MATHEMATICS PROBLEMS

III – 1 – 1½ – 3

Problems based on the content of Lecture Course 141.

I. C. Medland

140. MATHEMATICAL APPLICATIONS

IV – 1A, 1C – – 2 1½

The formulation, discussion and solution of certain civil engineering problems by numerical methods including relaxation techniques. Electronic digital computers are employed in appropriate cases.

R. A. Collins

141. ENGINEERING MATHEMATICS

III – 1 2 – 2 –

The solution of differential equations and their application in Civil Engineering. Textbook: *Applied Differential Equations* – Spiegel.

I. C. Medland

145. COMPUTER PROGRAMMING

II – 1 2 2 – –

The following topics are discussed: algorithms; number systems; components of a stored-program digital computer; programming techniques, with particular emphasis on flow-charts; types of languages; number representation in a computer; addressing. The Fortran IV language, as an example of an algebraic language, is studied extensively from a user's point of view. Problem-oriented languages for Civil Engineers, such as

COGO and STRESS, are introduced. Programming exercises accompany all instruction in flow-charting and languages.

R. A. Collins, K. A. Selby

152s. ENGINEERING OPTICS AND ASTRONOMY

II – 1 1 – 1 1½

Reflection and refraction at plane and curved surfaces; optical instruments – telescope, microscope; physical optics. Solution of spherical triangles, star co-ordinate systems; motions of celestial bodies; determination of azimuth, position and time using engineering instruments.

V. L. Henderson, H. Macklin

153. SURVEYING

II – 1 2 4 1 3

General principles and practice of surveying including: discussion of instruments for measurement of horizontal distances (tapes and electronic devices) horizontal and vertical angles (transit and theodolite) vertical distances (level and rod). Survey calculations, adjustments and corrections, including azimuths, bearings, latitudes, departures, co-ordinates, and areas. Simple, compound and reverse curves as used in Highway, Railroad and Cadastral surveying. Construction surveying dealing with cross-sections, earthwork quantities, vertical curves. Laboratory periods for practical applications to illustrate the above topics, first term on field problems, second term on calculations. Textbooks: *Surveying* – Philip Kissam; *Route Surveys* – Skelton.

O. J. Marshall, B. J. Haynes, H. L. Macklin

155. SURVEYING

II – 9 1 – 1 –

Introduction to surveying principles and practice. Theory and use of surveying instruments. Survey computations and error analysis, including quantity calculations. Mine surveys, topographic surveys, and introduction to practical astronomy. Textbooks: *Surveying Practice* – Kissam; *Surveying for Civil Engineers* – Kissam.

H. L. Macklin

156. SURVEYING LABORATORY

II – 9 – 1½ – 1½

First term – field problems using the transit, level and tape. Second term – survey computations related to Course 155.

H. L. Macklin

158. SURVEY CAMP

Course 1, III Year; Aug. 14 to Sept. 15 – Dorset or Gull Lake; Course 9, III Year; Sept. 5 to Sept. 15 – Gull Lake.

Course 9, III Year; Sept. 5 to Sept. 15 – Gull Lake.

Course 1:

(*a*) Secondary Triangulation and Base Line Measurements, (*b*) Highway Location, Cross Sectioning and Earthwork Computations, (*c*) Stadia and Plane Table Topography, (*d*) Distance Measurements by Electronic Methods, (*e*) Air Photo Interpretation, (*f*) Observations for Time, Azimuth, and Latitude.

Course 9:

(*a*) Topographic Surveying and Mapping, (*b*) Underground Surveying, including Shaft Plumbing and Use of Mine Surveying Instruments, (*c*) Route Surveys, Curve Layout, and Earthwork Quantity Computations, (*d*) Astronomic Observations for Time and Azimuth. Students in Courses 1 and 9 will be required to take the Survey Camp between the Second and Third Years. Application to defer attendance at the Camp must be made to the Secretary of the Faculty before July 15.

Staff in Civil Engineering

159. LEAST SQUARES

III – 1B – 3 – –

The general principles of probability of errors, elementary problems illustrating the application of Least Squares to the adjustment of observations, empirical constants and formulae. No laboratory reports shall be written outside the assigned teaching hours. Textbooks: *Survey Adjustment and Least Squares* – H. F. Rainsford. *Engineering Measurements* – B. Austin Barry.

H. L. Macklin

160. GEODETIC ENGINEERING

III – 1B – – 2 –

Principles, equipment and methods of geodetic survey involving triangulation, traverse and levelling of high precision; elementary geodesy and map projections.

O. J. Marshall

161. GEODETIC ENGINEERING LABORATORY

III – 1B – – – 3

Problems and computations supplementing the work covered in subject 160.

O. J. Marshall, B. J. Haynes

162. PHOTOGRAMMETRY I

III – 1B, 9 2 – – –

Photograph as central projection, interior geometry of surveying camera, stereoscopic vision and methods of viewing stereo, methods of terrestrial photogrammetry, aerial photography, geometry of single picture, radial line triangluation, geometry of stereopairs, theory and practice of reconstruction of spatial models, plotting instruments, introduction to analytical methods.

J. Vlcek

163. PHOTOGRAMMETRY I. LABORATORY

III – 1B, 9 – 3 – –

Laboratory work supplementing the lecture course 162.

J. Vlcek

164. PHOTO INTREPRETATION

III – 1B – – 2 –

The principles of intrepretation of aerial photographs; geological processes of formation of landforms, both consolidated and unconsolidated, with particular emphasis on Pleistocene geology; the patterns of landforms as seen on aerial photographs; their identification and evaluation, and the engineering problems involved; location of granular material; soil mapping; drainage area delineations; highway, powerline, pipeline and flood control structure investigations; classification of muskeg and prediction of depth; selection of photo control points and optimum monumentation sites; optimum locations of trial survey lines; tree species identification.

S. G. Bird

165. PHOTO INTREPRETATION LABORATORY

III – 1B – – – 3

Laboratory work supplementing the lecture course 164.

S. G. Bird

167. SURVEY CAMP

Course 1B, IV Year; Aug. 21 to Sept. 15, Gull Lake.

Triangulation, trilateration, electronic distance measurements, traverses, levelling and astronomical observations by precise methods.

O. J. Marshall, H. L. Macklin, R. C. Gunn

168. GEODETIC ADJUSTMENTS

IV – 1B 1 3 1 3

The theory of the adjustment and analysis of geodetic measurements. The design and statistical analysis of engineering control surveys. The application of the electronic computer to survey adjustment problems. Laboratory periods deal with the problems of design, analysis and adjustment of control surveys. Heavy emphasis is placed upon the programming and solution of the above problems by electronic digital computer.

R. C. Gunn

170. PHOTOGRAMMETRY II

IV – 1B 1 3 1 1½

Review of elementary matrix theory, orthogonal and skew-symmetric matrices, theory of model restitution, linear conformal transformations in 2-space and 3-space and their applications in photogrammetry, methods of serial triangulation, non-linear transforma-

tions in 2-space and 3-space and their applications in the adjustments of strips and blocks of models, analytical model reconstruction. Laboratory work consisting mainly of computer programming of photogrammetric problems.

J. Vlcek

172. ASTRONOMY

IV – 1B – – 1 3

Precise determination of time, latitude, longitude and azimuth as applied to geodetic surveys. Observations and problems.

H. L. Macklin, R. C. Gunn

174. ENGINEERING AND LEGAL SURVEYS

IV – 1B 1 – 2 –

Construction surveying problems dealing with prismoidal volumes and corrections, hydrographic surveying, tunnel surveying, circular curve intersections, area computations, chronological order of land subdivision and layout from early township patterns to present-day subdivisions, the weighing of survey evidence in the retracement of construction and legal surveys, and the preparation of legal surveys.

B. J. Haynes

175. GEODESY AND ELECTRONIC SURVEYING

IV – 1B 2 1½ 2 3

Ellipsoidal geometry, deflections of the vertical, reduction of geodetic measurements to the ellipsoid, geodetic position computations, electronic surveying, map projections. Problems in geodetic computations, the reduction of electronic distance measurements, the calculation of geodetic positions, map projection co-ordinates.

R. C. Gunn

180. SANITARY ENGINEERING

III – 1 2 – – –

The objective of Sanitary Engineering and Pollution Control. Basic outline of problems of urbanization and the natural cycle of water. Water Purification. Treatment of domestic and industrial waste waters. Municipal Services – water mains, sanitary sewers, storm water drainage, garbage disposal. Air Pollution Control – equipment and planning considerations.

A. P. Bernhart

181. POLLUTION CONTROL SCIENCES

IV – 1C (elective) 3 2 – –

A lecture and laboratory course designed to relate the basic sciences with their application in waste water and water treatment. Subject matter dealt with includes: Chemistry, Microbiology, Theory of Settling, Filtration, Coagulation, Ecology.

P. H. Jones and G. W. Heinke

182. MUNICIPAL ENGINEERING

IV – 1C (elective) – – 3 2

Quantities of water and waste water, hydrology, waste water collection systems, water distribution systems, municipal roads, refuse disposal, administration and financing of municipal works. Laboratory: Design Problems supplementing lecture material. Textbooks: *Water and Waste Water Engineering* – Fair, Geyer and Okun, Volume I. *Design and Construction of Sanitary and Storm Sewers* – WPCF Manual. References: *Water Supply and Pollution Control* – Clark and Viessman. *Hydrology for Engineers* – Linsley, Kohler and Paulhus.

G. W. Heinke

183. POLLUTION CONTROL ENGINEERING

IV – 1C (elective) – – 3 2

Air pollution control, water supply and purification, municipal waste water treatment, industrial waste water treatment, soil pollution control.

A. P. Bernhart

184. ENVIRONMENTAL PLANNING

IV – 1C (elective) 3 2 – –

Environmental planning: physical, economical, biological, sociological, spiritual; new theory based on the philosophy of seven dimensions; emerging form of urban life; shaping the metropolis; metropolis within the region; green belts and satellites; pollution control; redevelopment.

A. P. Bernhart

185. HIGHWAY ENGINEERING

III – 1 2 – – –

Organization, administration, economics and planning of rural highways; highway materials and paving; principles of location, design, construction and maintenance. Textbook: *Highway Engineering* – Oglesby and Hewes, 2nd Edition. Reference books: *The Highway Improvement Act – Ontario Highway Standards and Specifications* – Department of Highways of Ontario. *Soil Mechanics for Road Engineers* – D.S.I.R. – H.M. Printer, *Policy on Geometric Design of Rural Highways* – A.A.S.H.O.

M. M. Davis

186s. MUNICIPAL PLANNING, ADMINISTRATION AND TRANSPORTATION

III – 1 – – 3 –

Contemporary concepts in urban and regional planning and their theoretical, practical and legal applications as applied in Canada. Organization of municipal government, municipal finance, legislation governing municipal operation, role of the municipal engineer and private practitioner in public works, provisions of municipal services. Urban and regional growth as affected by transportation, trends, demands, charac-

teristics and capacities, co-ordination with land use and integration with other services.

M. M. Davis, H. L. Macklin, D. F. D. Pinker

187. TRAFFIC ENGINEERING

IV – 1C (elective) 3 2 – –

Urban transportation planning, traffic studies, forecasting models, characteristics of traffic flow, traffic control at intersections, methods of project evaluation. Textbook: *Traffic Engineering Handbook*. References: *Principles and Techniques for Predicting Future Demand for Urban Area Transportation* – Martin, Memmott, and Bone; *Highway Capacity Manual.*

R. M. Soberman

188. TRANSPORTATION ENGINEERING

IV – 1C (elective) – – 3 2

Characteristics of Transportation Systems, Railway and Airport Engineering, Theory of Traffic Flow, Behaviour and Design of Flexible and Rigid Pavements. Reference books: *Introduction to Transportation Engineering* – Hay; *Planning & Design of Airports* – Horonjeff; *Soil Mechanics for Road Engineers* – D.S.I.R.; *Principles of Pavement Design* – Yoder; *Poisson & Traffic* – Eno Fndn.

M. M. Davis, R. M. Soberman, R. G. Rice

189. AIR PHOTO INTERPRETATION

IV – 1C (elective) 3 2 – –

The principles of interpretation of aerial photographs; processes of formation and erosion of landforms, both unconsolidated and consolidated, with particular emphasis on glaciation, their patterns as seen on aerial photographs, their identification and evaluation, and the engineering problems involved; location of granular materials; soil mapping; investigations from airphotos for highway, powerline, and pipeline locations, damsites and flood control structures; delineation of drainage areas and drainage structure location; classification of muskeg areas and prediction of depth; land use classification. One day field trip, including field soil testing.

S. G. Bird

191. SOIL MECHANICS

III – 1 2 1½ – –

Identification and classification of soils for engineering purposes, weight volume relationships, compaction, permeability and drainage characteristics, effective stresses, shearing strength, site exploration and soil sampling, lateral earth pressure.

F. A. De Lory

192. SOIL MECHANICS AND FOUNDATIONS

IV – 1A, 1C 2 – 1 2

Shearing strength, bearing capacity, footings, consolidation and settlement, lateral

pressures, retaining walls, braced cuts and cofferdams, pile and caisson foundations, sheet pile bulkheads, slope stability, flow nets, dewatering. Laboratory testing and problem periods. No laboratory reports to be written outside assigned laboratory hours.

F. A. De Lory, T. C. Kenney

193. FOUNDATIONS AND EARTHWORKS

IV – 1C (elective) – – 3 2

Design and construction of: Foundations for buildings, bridges and other structures including excavation, footings, piling, caissons; Retaining walls, sheet pile bulkheads, tunnels; Fills, embankments, earth-fill and rock-fill dams including seepage, dewatering and grouting. Geotechnical processes and field measurements and control.

F. A. De Lory, T. C. Kenney

194s. ENGINEERING GEOLOGY

IV – 1C (elective) 3 2 – –

The study of engineering practice from a geological point of view. The behaviour of rocks and soils in building and engineering construction, foundations, tunnels, dams, and flood-control works with reference to the importance of the mineral composition of earth and rock materials, their geomorphic and geologic features and their stress history. Engineering case studies will include examination of groundwater, frost and landslide conditions, shoreline engineering, construction in permafrost, earthquake problems, and field investigations.

E. I. Robinsky and Geology Department

195. MINING

II – 9 1 – 1 2

A combined lecture and laboratory subject in the principles of mining and its unit processes. Emphasis is placed on the statistical approach to sampling calculations.

H. R. Rice

196. MINING TECHNOLOGY AND MINERAL DRESSING

III – 9 2 – 2 –

An introduction to mining practice with emphasis on current mining methods as applied to geological situations and stress environments; current practices in mineral beneficiation processes.

H. R. Rice

197. MINE OPERATION AND ADMINISTRATION

IV – 9 2 – 2 –

Mine operation with special attention paid to mine services; administration dealing with aspects of economics, industrial engineering, finance, and industrial relations.

H. R. Rice

198. MINING LABORATORY

IV – 9 – 3 – 3

Problems in mine layout involving shaft location and size; mine development; choice of stoping methods, mining rate, and mine equipment; time and cost schedules; ore reserve calculations.

H. R. Rice

DEPARTMENT OF MECHANICAL ENGINEERING

302. ENGINEERING THERMODYNAMICS

II – 1 – – 1½ –

The fundamentals of engineering thermodynamics. The First and Second Laws. Properties of substances. Heat transfer. Heat exchangers. Compressors, fans, pumps, reciprocating engines and turbines. Vapour and gas power cycles. Refrigeration. Air-conditioning.

P. B. Hughes

308. HEAT ENGINEERING

III – 3 2 – – –

Applications of thermodynamics to machines, including: background to the development of heat engines; basic steam power plant cycles and design; internal combustion engines and cycles; combustion calculations; fuel and exhaust products analysis; power plant testing; heat transmission; psychrometry and air conditioning.

A. B. Allan

309. ENGINEERING THERMODYNAMICS

III – 3 2 – 2 –

Fundamentals of the effects of heat on fluids, including: first and second laws of thermodynamics; ideal processes using gases and vapours; reversibility, availability and entropy; properties of real and ideal fluids; processes and cycles for gas and vapour power plants; processes and cycles for refrigeration.

F. C. Hooper

310. HEAT ENGINEERING LABORATORY I

III – 3 – 3 – 3

Complementary to lecture subjects 308 and 309. The experimental work, conducted on a broad range of heat and power equipment, is intended to offer experience in the design, organization and execution of experimental investigations of thermal apparatus, in the application and evaluation of the associated instrumentation, in the treatment of the data, and in the interpretation and reporting of the work. Textbook: *The Engineering Report in the Undergraduate Laboratory* – Hughes.

311. ENGINEERING THERMODYNAMICS

III – 4 – – 2 –

The applications of the laws of thermodynamics to ideal processes and cycles using gases and vapours, reversibility, available energy, entropy, properties of fluids. Processes and cycles used in practice for steam and gas power plants, and for refrigerating plants. Reciprocating engines, turbines and compressors. Heat transfer. Textbook: *Thermodynamics of Heat Power* – Faires.

P. S. Shen

312. HEAT ENGINEERING LABORATORY

III – 4 – – – 3

This laboratory is complementary to lecture subject 311. Selected experiments are conducted in illustration of the methodology of experimental investigation of the external characteristics of thermal devices and systems, with special attention given to the peculiar interests of the engineer primarily concerned with economic considerations. Textbook: *The Engineering Report in the Undergraduate Laboratory* – Hughes.

313. HEAT ENGINEERING

III – 5nt 1 – 1 –

This course consists of a study of the fundamental concepts of macroscopic thermodynamics, and their applications to closed and open dynamic systems. An examination of the principal power cycles is undertaken in relation to the properties of the working media involved. Emphasis is placed on a thorough understanding of the three basic laws of thermodynamics. Textbook: *Concepts of Thermodynamics* – Obert. Reference books: *Engineering Thermodynamics* – Hall and Ibele. *Thermodynamics* – Van Wylen.

C. A. Ward

314. HEAT ENGINEERING LABORATORY

III – 5nt – 3 – 3

This laboratory is complementary to lecture subject 313. The course emphasizes the philosophy and techniques used in the experimental investigation of the performance of heat engineering equipment. Textbook: *The Engineering Report in the Undergraduate Laboratory* – Hughes.

322s. THERMAL ENERGY CONVERSION I

IV – 3 2 – 2 –

A continuation of subjects 308 and 309, and complementary to subject 323, this course deals with the plants and processes used in major power production. The overall design and heat balance in steam power plants is considered, and their components are examined. Both conventional fossil fuel and nuclear energy sources are considered. New developments and trends are introduced. Textbook: *Power Plant Theory and Design* – Potter.

P. B. Hughes, D. G. Andrews

323. THERMAL ENERGY CONVERSION II

IV – 3 – – 2 –

A continuation of subjects 308 and 309, and complementary to subject 322, this course deals with non-central power production as for shaft power, propulsion, and similar applications. A survey of present and potential fuel resources. Operating cycles and characteristics of internal combustion engines, including reciprocating, rotary positive and gas turbine types. Rockets and ramjets. Design factors. The principles and potential of devices under current development, including fuel cells, thermoelectric converters and magnetohydrodynamic power generation. Reference book: *The Internal Combustion Engine* – Taylor and Taylor.

A. B. Allan

324. HEAT ENGINEERING LABORATORY

IV – 3 – 3 – 4½

This laboratory is complementary to lecture subjects 322 and 323. It is an extension of the third year laboratory, subject 310, with an increased demand for individual judgment and a professional outlook. Textbook: *The Engineering Report in the Undergraduate Laboratory* – Hughes.

328. HEAT TRANSFER

IV – 5nt – – 2 –

Steady state and transient conduction, surface and gas radiation, convection, boiling, condensation and combined mechanisms are considered. Special attention is given to analogue and computational procedures and to consideration of the manner in which novel or complex problems may be approached. Textbook: *Heat Transmission* – McAdams.

F. C. Hooper

331. THERMAL ENERGY CONVERSION

IV – 5nt 3 – 3 –

The thermodynamics and gas dynamics of thermal energy conversion. Steam power cycles, nuclear reactor and fossil fuel energy sources, magnetohydrodynamics power generation, fuel cells, combustion, refrigeration, new trends and research developments.

D. S. Scott

332. HEAT ENGINEERING LABORATORY

IV – 5nt – 3 – 3

This laboratory is complementary to lecture course 331, and an extension of course 314. The techniques of testing, the design of experiments, the application of instrumentation, and the organization and reporting of performance tests are emphasized.

333. FLUID MECHANICS

III – 1 2 – 2 3

Introductory concepts; fluid properties; dimensional analysis; fluid statics; kinematics

and dynamics of flow; laminar and turbulent flow; applications to closed-conduit and open-channel flow; draw and lift on submerged bodies.

J. F. Keffer

334. FLUID MECHANICS I

III – 3 2 – 2 3

Introductory concepts; fluid properties, dimensional analysis; hydrostatics; kinematics and dynamics of flow; irrotational flow and vorticity; dynamic lift; laminar flow; turbulent flow; applications to closed-conduit and open-channel flow; one-dimensional compressible flow.

G. R. Lord

337. FLUID MECHANICS

III – 4 2 3 – –

The fundamentals of fluid flow as generally encountered in industry; fluid properties; fluid statics; energy relationships; dimensional analysis and dynamic similarity; flow in pipes and channels; resistance of submerged bodies; effects of viscosity and compressibility; applications.

D. F. James

338. FLUID MECHANICS

III – 5c 2 3 – –

Presentation of fundamentals of continuum fluid motion; introductory concepts; kinematics and dynamics of flow; irrotational motion; viscous laminar and turbulent flow; thermodynamic relationships; gravity effects; applications.

J. F. Keffer

339. FLUID MECHANICS

III – 6 2 3 – –

Introductory concepts; fluid properties; fluid statics; kinematics and dynamics of flow; laminar and turbulent flow; closed-conduit and open-channel flow; compressibility effects; drag and lift on submerged bodies; elementary turbomachinery.

D. F. James

340. FLUID MECHANICS

III – 5nt 2 3 2 3

A fundamental approach to the mechanics of fluid motion; continuum concepts; kinematics and dynamics of flow; irrotational motion; vorticity; laminar flow solutions; turbulent motions; applications to conduit flow; thermodynamic relationships; elementary thermal transport; free surface waves; fluid machinery.

W. D. Baines, D. F. James

341. FLUID FLOW AND HEAT TRANSFER

III – 8 2 – 2 3

A study of the forces and motion produced by various fluid properties. Gravitational, viscous and inertial forces are considered in detail. Momentum, energy and continuity relation, boundary-layer approximation, turbulence, flow in pipes and around submerged bodies. Steady-state conduction in one dimension; extended surfaces; heat conduction with two or more independent variables; forced convection and dimensional analysis; heat transfer by free convection; radiant heat transfer; heat transfer by combined conduction and convection; heat transfer in liquid metals.

A. H. Abdelmessih, H. J. Leutheusser

343. HYDRAULIC ENGINEERING

IV – 1 2 3 – –

The general field of hydraulic engineering is studied under the topics: hydrology; ground and surface water; drainage, flood control, power and navigation systems; municipal and industrial applications; model studies; principles of design, operation, and field investigation.

W. D. Baines

344. HYDRAULICS

IV – 3 2 – 2 –

The general field of applied hydraulics and fluid mechanics is studied under the topics: hydrology; hydro-electric power plants and auxiliaries; conservation and flood control; canals, pipelines, etc., under both steady and unsteady conditions; hydraulic machinery, fans, compressors, turbines, pumps, etc., design, selection and operation; power and control circuits; flow of compressible fluids; similarity and model investigations; industrial applications.

H. J. Leutheusser

345. HYDRAULIC LABORATORY

IV – 3 – 3 – 4½

Experimental work is carried out in the laboratory on various types of pumps, turbines, fans, centrifugal compressors and on hydraulic models. In addition computation problems involving open channel flow, water power studies, pumps and turbine studies, water hammer phenomena, fans and ductwork and other advanced flow problems are considered. General problems involving compressibility of gases are considered.

350. DYNAMICS

II – 1 1½ – – –

Motion of a point is reviewed and extended to include Coriolis' acceleration, with applications. Equations for motion of mass in translation, rotation, and plane motion are developed, including centre of percussion. An introduction to vector mechanics is given. Moment of inertia of mass is studied by double integration and by the lamina

method. The derivation and application of gyroscopic action is thoroughly discussed, and an introduction to static and dynamic balancing is given. Elementary vibration theory and problems in vibration isolation are discussed. Textbook: *Engineering Dynamics* – Hooper and Smith. Reference book: *Mechanics* – Part II – Meriam; *Engineering Mechanics,* Vol. II, Vector Edition, Higdon & Stiles.

D. L. Allen

351. DYNAMICS

II – 3 3 1 – –

Calculus of vectors; particle motion; systems of particles; rigid bodies; virtual work and D'Alembert's principle; introduction to Lagrange equations; introduction to mechanical vibrations. Textbook: *Housner and Hudson* – Applied Mechanics-Dynamics.

Staff in Mechanical Engineering

352. DYNAMICS

II – 7 2 – 1 –

Dimensional units; vectors; kinematics, rectilinear and angular motion, plane motion, projectiles, satellite orbits, rigid body concept, relative motion with respect to translating and to rotating vehicles; kinetics, force, d'Alembert's principle, rotation, translation, vibration of mechanical and electrical systems, work, energy, conservation of energy, power, impulse, momentum, rockets, jets, fluid mechanics, impact, balancing, centrifugal and Coriolis' force, critical speeds, gyroscopic effect. Reference book: *Dynamics* – Merriam.

F. P. J. Rimrott

353. DYNAMICS LABORATORY

II – 7 – 1½ – 1½

Course 7, II Year; 1½ hrs. problems per week, both terms. Problems in kinematics and kinetics to support subject 352.

356. DESIGN OF MACHINE ELEMENTS

II – 3 – – 2 –

Course 3, II Year; 2 hrs. lectures per week, second term. Standard methods for the design of belts, shafts, spur gears, bearings, brakes, clutches, couplings, power screws, fasteners, rivets and welded components. Textbook: *Mechanical Engineering Design* – Shigley.

R. T. Waines

357. DESIGN LABORATORY

II – 3 – – – 3

Design of machine parts and simple machines, including drafting and assembly layout. Fits, tolerances and metrology.

R. T. Waines

358. THEORY OF MACHINES

II – 3 – – 2 3

Equations for accelerated motion of mass applied to the analysis of machine elements. Velocity, acceleration, force distribution, speed fluctuation and balancing of machine parts and machines. Cams, gears, flywheels and linkage kinematics. Textbook: *Kinematics and Dynamics of Machinery* – Maxwell.

G. E. Godfrey

360. SYSTEMS DYNAMICS

III – 3 1 – 1 –

Setting up of the differential equations of physical systems; frequency response and bandwidth concepts; the analogue computer; transducers and instrumentation; frequency response and transient response, consideration in the matching of processes.

B. Tabarrock

361. VIBRATIONS

III – 3 2 – – –

Single-degree-of-freedom systems, damped and undamped; multi-degree-of-freedom systems; method of determining natural frequencies; characterization of physical systems by mathematical models; response of such systems to steady-state single-frequency excitation and to transient pulses; beams and strings.

D. L. Allen

362. DYNAMIC MEASUREMENTS LABORATORY

III – 3 – 3 – 3

A combined laboratory course for Vibrations (361) and Systems Dynamics (360). Includes: comparative experiments with transducers; analogue computer study of transient and frequency response behaviour of physical systems; vibration experiments; experimental study of electrical-mechanical-fluid-thermal analogies; measurements of the process dynamics of a variety of systems, including consideration of the optimum choice of transducers and instrumentation and the comparison of transient and frequency response.

363. ENGINEERING DESIGN

III – 3 – – 2 –

Approach to engineering design; problem definition; generating and comparing concepts; synthesis-analysis-evaluation decisions under realistic situations. Engineering examples and small design projects utilizing available background of mathematics, mechanics, circuits and thermodynamics. Specific attention is given to such subjects as springs, curved beams and experimental stress analysis.

I. W. Smith

364. ENGINEERING DESIGN LABORATORY

III – 3 – – – 3

A laboratory course complementary to the lectures of subject 363, Engineering Design.

365. APPLIED ELASTICITY

III – 5nt, 5p 1 – 1 –

Introduction (simple equations for normal and shear stresses; stress concentrations; fluctuating stresses and fatigue). Analysis of stress and strain in three dimensions, including use of primary and auxiliary Mohr's circles, and application to bending and torsion problems. Deflection analysis of statically determinate and indeterminate structures. Additional topics and applications include: Analysis of plates and shells, torsion of thin-walled tubes, stability of columns, thermal stresses.

G. E. Godfrey

366. APPLIED ELASTICITY LABORATORY

III – 5nt, 5p – 3 – 3

Problems to support subject 365.

373. MACHINE DESIGN

IV – 3 2 – 2 –

Although the design of some specific machine elements is covered, such as springs, ropes and curved frames, most of the course is concerned with design concepts, including organization, reliability and creativity. An introduction to the field of theoretical mechanics includes elasticity, plasticity, thermal stress, vibrating systems and advanced kinematics. Textbooks: *Mechanical Engineering Design* – Shigley. *Vibration Theory and Application* – Thomson. *Theory of Elasticity* – Timoshenko and Goodier.

I. W. Smith, B. Tabarrok

374. MACHINE DESIGN LABORATORY

IV – 3 – 3 – 4½

Design and research projects utilizing the concepts given in Subject 373 and emphasizing the creative approach. Seminars on new developments in the design field are held.

380. DIFFERENTIAL EQUATIONS

II – 3 – – 2 1

Engineering applications of elementary differential equations, to include such topics as operational methods, elementary nonlinear equations, simultaneous differential equations.

B. Tabarrock

386. ENGINEERING MATHEMATICS I

III – 3 3 1 3 1

Analytical techniques used in mechanical engineering, including such topics as:

numerical methods, vector analysis, complex variables, differential equations with variable coefficients, Sturm-Liouville systems; introduction to partial differential equations.

A. H. Abdelmessih, D. S. Scott

390. APPLIED MATHEMATICS IN ENGINEERING

IV – 3 1 3 2 3

Solutions of the heat conduction equation; steady one-dimensional systems; extended surfaces; applications of Fourier series to steady two-dimensional and transient systems; differential equations of Bessel and Legendre.

J. F. Keffer

391. ELEMENTARY CONTROL THEORY

IV – 3 1 – 1 –

An introduction to the principles utilized in the analysis of linear control systems. Emphasis is also placed on the synthesis of mathematical models of simple systems, and the limitations inherently involved. Topics include stability criteria, characteristics of electrical, pneumatic and hydraulic control elements, and capabilities of feedback systems. A brief introduction to the problems arising from non-linear prototypes is included. Recommended text: *Automatic Control Engineering* – Raven.

J. VandeVegte

392. ELEMENTARY CONTROL THEORY LABORATORY

IV – 3 – – – 3

Problems and experiments related to subject 391.

393. COMPUTATIONAL METHODS

IV – 5nt, 1 3 1 3

Practical extension of Subjects 2427 and 2428 to provide advanced computing experience with desk calculators and with analogue and digital computers. FORTRAN computer language will be studied in detail. Emphasis is placed on the economic use of available numerical procedures in the solution of engineering problems.

L. E. Jones

394s. CONTROL ENGINEEERING

III – 4 2 – 2 –

An introduction to the dynamic behaviour of linear systems; the feedback principle; the stability of linear control systems; the convolution theorem; transfer functions of linear systems; analysis and synthesis of linear control systems; introduction to servomechanism technology.

J. VandeVegte, A. Porter

395s. CONTROL ENGINEERING LABORATORY

III – 4 – 3 – 3

Problems and laboratory experiments to accompany subject 394s.

J. VandeVegte, A. Porter

396. INDUSTRIAL MANAGEMENT

IV – 3 1 – – –

Introduction to principles of management and organization. Subjects 3440 and 396 are combined in one examination.

P. B. Hughes

398. CONTROL SYSTEMS

IV – 5g, 5nt 1 – 2 –

A course in linear and non-linear control systems.

J. VandeVegte

399. CONTROL SYSTEMS LABORATORY

IV – 5g, 5nt – – – 3

A laboratory course accompanying subject 398.

DEPARTMENT OF INDUSTRIAL ENGINEERING

414s. ELEMENTS OF INDUSTRIAL ENGINEERING

II – 4 2 – 2 –

A broad survey of both old and new elements of Industrial Engineering, with selected reading and essay assignments, including work study, wage determination, controls of production, quality and cost, mathematical models of production and distribution systems, computer simulation techniques, operations research, human factors studies, and management science.

T. C. Graham, A. Porter

415. AUTOMATIC CONTROL OF PROCESSES

IV – 4 2 – 2 –

Automatic control in the process industries and in the control of machine tools. Problems of on-line computer control. Relation to over-all problems of system planning and management control.

416. HUMAN FACTORS ENGINEERING

IV – 4 3 – 3 –

A general introduction to the Bio-Sciences; detailed analysis of the structure and functioning of the central nervous system, and the special senses, in particular the visual

phenomena which characterize man's interaction with his environment; application of this knowledge to selected problems in man-machine systems. Reading will be assigned as the course progresses.

P. J. Foley

417. INDUSTRIAL ENGINEERING SEMINAR

IV – 4 – 2 – 2

Members of the staff in Industrial Engineering, and invited speakers prominent in the academic, governmental, and business communities, will conduct a series of talks followed by general discussion. Two essays, on one or more of the subjects discussed, will be required.

418. MANAGEMENT SCIENCE

IV – 4 2 – 2 –

Theories and methods of analysis to optimize product mix, process selection, equipment investment, production and distribution activity levels, competitive strategies, information flow and processing, organization, and control. Assessment of the accuracy, precision, and relevance of demand, cost, and technological data used in analyses, as obtained from designed industrial experiments, sampling, sample surveys, correlation of uncontrolled variables, and various internal and external agencies. Prerequisited are probability and statistics, linear algebra, and elementary differential equations. Textbook: *Concepts in Management Science* – Donald Clough; Prentice-Hall.

419. OPERATIONS RESEARCH

IV – 4 2 3 4 3

Mathematical methods of operations research. Lagrange multiplier methods, linear and non-linear programming, dynamic programming, with assigned problems in production scheduling and sequencing, inventory control, transportation, machine replacement, and resource allocation. Systems of linear differential equations, complex variable theory, Markov theory, applied to queueing, inventory, maintenance, reliability, replacement, and information processing problems. Prerequisites are probability and statistics, linear algebra, and elementary differential equations. A term test will be given at mid-session which will contribute 33% of the total course mark.

Staff in Industrial Engineering

420. SYSTEMS THEORIES

IV – 4 2 3 2 3

Theories of automata; information theory; organization systems theories; computer simulation models applied in the design and analysis of production and distribution systems and their concomitant control systems.

Staff in Industrial Engineering

421. THESIS PROJECT

IV – 4 – 6 – 6

Design and analysis of an engineering system to satisfy certain objectives and requirements (e.g. the production of a specific product). This project will provide the student with an opportunity to apply the knowledge and techniques of analysis acquired in all the other Industrial Engineering subjects. The work will be carried out under the supervision of staff members. Progress reports and a written thesis are required.

Staff in Industrial Engineering

422. COMPUTER PROGRAMMING I

II – 4 1 1½ 1 1½

Coding and programming for the digital computer; machine organization, machine language and symbolic compiler langauge (FORTRAN IV); number representation and conversion. Laboratory exercises are drawn from the fields of engineering and applied science, as well as from those of data processing and elementary compilation.

R. W. P. Anderson

423. COMPUTER PROGRAMMING II

III – 4 1 1½ 1 1½

An extension of the Second Year subject Computer Programming I. More advanced discussion of general and specialized compiler languages and their application in business, engineering and other fields; simulation, data processing, and list processor languages; monte carlo methods; GPSS, SIMSCRIPT, COBOL, etc. Laboratory problems are selected to complement the lecture material.

R. W. P. Anderson, S. Cohn

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

600. CHEMISTRY

I – 1, 3, 4, 6, 7, 8, 9 2 – 2 –

Chemical theory, with industrial and engineering applications.

The Staff in Chemical Engineering

601. CHEMICAL LABORATORY

I – 1, 3, 4, 5, 6, 7, 8, 9 – 3 – 3

A laboratory course illustrating the fundamental laws of chemistry as dealt with in the lecture course, and providing an introduction to chemical analytical methods.

W. F. Graydon, M. J. Phillips, S. Sandler, A. M. Rozeiu

602. CHEMISTRY

I – 5 2 – 2 –

Introductory physical chemistry: the gas laws, chemical equilibria, elementary solu-

tion chemistry, thermochemistry. Problems dealing with industrial and engineering applications.

W. H. Burgess

607. ENGINEERING CHEMISTRY

II – 1 2 – – –

Corrosion and water-treatment; introduction to organic chemistry.

S. Sandler

608. PHYSICAL CHEMISTRY

II – 5 2 – 2 –

The themes discussed are conservation, equilibrium and rate of change in chemical systems. These are applied to topics in thermo-chemistry, phase equilibrium, reaction equilibrium, including reactions in cells, and reaction kinetics. Reference books: *Physical Chemistry,* by F. Daniels and R. A. Alberty, 3rd ed.; *Physical Chemistry,* by W. J. Moore, 3rd ed.

R. W. Missen, C. E. Chaffey

609. PHYSICAL CHEMISTRY LABORATORY

II – 5 – 1½ – 1½

Experimental work and problems periods to accompany subject 608. In the second term, each student performs a laboratory investigation of an individual problem of a research type. Alternate periods are devoted to solving assigned problems.

R. W. Missen, C. E. Chaffey

613. ANALYTICAL CHEMISTRY AND COMPUTATION LABORATORY

II – 6

This course commences on the Wednesday following the first Monday in September, and continues until the opening of the Fall Term. All the working time will be spent on systematic quantitative inorganic analysis and machine computation. Textbooks: *Textbook of Inorganic Analysis* – Kolthoff and Sandell; *A Guide to Fortran Programming* – D. D. McCracken.

I. H. Spinner, M. E. Charles, J. Binkiewicz

614. ANALYTICAL CHEMISTRY LABORATORY

II – 6 – 9 – –

A continuation of subject 613.

I. H. Spinner, W. A. M. Hewer, J. Binkiewicz

615. ANALYTICAL CHEMISTRY

II – 6 2 – – –

Equilibrium considerations in quantitative analysis.

I. H. Spinner

617. INORGANIC CHEMISTRY

II – 6, 8, 9 1 – 2 –

The constitution of matter and classification of the elements: systematic inorganic chemistry.

R. L. Hummel, R. E. Jervis

619. CHEMICAL ENGINEERING SCIENCE LABORATORY

II – 6 – – – 7½

Experiments illustrating the kinetic and equilibrium principles of chemical engineering. Mass and heat balance calculations. One laboratory report per week.

I. H. Spinner, W. A. M. Hewer, C. P. Brockett, M. J. Phillips

620. PROCESS CALCULATIONS

II – 6 – 3 – 3

Process calculations in chemical engineering. Textbook: *Basic Principles and Calculations in Chemical Engineering* – Himmelblau.

J. W. Smith, W. G. MacElhinney

622. PHYSICAL CHEMISTRY

II – 6, 9 2 – 2 –

Chemical thermodynamics, phase rule and phase diagrams, electrochemistry, colloids and surface chemistry, kinetics.

R. W. Missen

625. REACTION KINETICS

III – 6 1 – 1 –

Chemical kinetics; principles of adsorption and colloid chemistry.

W. H. Burgess

626. SYNTHETIC CHEMISTRY

III – 5c 2 – 2 –

A course in synthetic chemistry covering the principles of systematic organic chemistry and systematic inorganic chemistry.

R. Woodhams

627. CHEMICAL LABORATORY

III – 6 – 6 – 6

A laboratory course to accompany subject 640. One laboratory report.

W. F. Graydon, Z. May

628. ORGANIC CHEMISTRY

III – 6 2 – 2 –

An introductory course in organic chemistry.

J. G. Breckenridge

629. ORGANIC CHEMISTRY LABORATORY

III – 6 – 6 – 9

A laboratory course accompanying subject 628.

W. H. Rapson, Z. May

630. INDUSTRIAL CHEMISTRY

III – 6 2 – 1 –

Selected topics in the chemical process industries. The course illustrates how the principles of chemistry, engineering and economics are applied in chemistry. Students are expected to read *Chemistry and Industry* – D. G. Jones.

Staff in Chemical Engineering

631. INTRODUCTION TO MASS AND HEAT TRANSFER

II – 6 2 – 2 –

The fundamental theory and practice used in transfer operations in chemical engineering. Energy and mass transfer are considered in the study of the flow of fluids, fluidization of solids, heat transfer, and evaporation of solutions. Textbook: *Chemical Engineering,* Vol. I – Coulson and Richardson.

W. G. MacElhinney

632. FLUID MECHANICS

III – 6 – – 2 –

Applications of the fundamentals of fluid mechanics in chemical engineering, with emphasis on single and two-phase flow with and without heat transfer, fluid-particle dynamics and non-Newtonian fluid flow. Textbook: *Chemical Engineering,* Vols. I and II – Coulson and Richardson.

M. E. Charles

633. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

III – 6 1 1 1 1

The first term is devoted to analysis and solution of chemical engineering problems which require knowledge of the rational design of experiments, treatment of experimental data and tests of hypotheses. The second term is devoted to applications of differential equations to problems of chemical engineering interest; emphasis is on the formulation of differential equations, together with their solution by analytical and numerical methods. Reference Books: *Probability and Statistics for Engineers* – I. Miller and J. E. Freund. *Engineering Statistics* – A. H. Bowker and G. J. Lieberman. *Applied Differential Equations* – M. R. Spiegel.

I. H. Spinner, R. W. Missen

640. CHEMICAL ENGINEERING THERMODYNAMICS

III – 5c, 6 2 2 2 2

A tutorial course in classical thermodynamics with problems in the field of applied

chemistry and chemical engineering. Special emphasis is placed on chemical processes and compositional changes.

W. F. Graydon

641. CHEMICAL ENGINEERING RATE PROCESSES

III – 5c – – 3 –

Introduction to mass, momentum and energy transport. Kinetic theory of gases, calculation of transport properties; analytical solutions of problems in viscous flow, heat conduction and mass diffusion; turbulent transfer coefficients; applications to chemical engineering systems. Textbook: *Transport Phenomena* – Bird, Stewart and Lightfoot.

O. Trass

642. CHEMICAL ENGINEERING PROBLEMS AND LABORATORY

III – 5c – 9 – 7½

Problems and laboratory experiments illustrating topics discussed in subjects 640 and 641.

Staff in Chemical Engineering

650. MASS TRANSFER OPERATIONS

III – 6 2 1 2 1

III – 6 2 – 2 –

The theory and practice of mass transfer operations in chemical engineering are discussed. Many problems in distillation, extraction, absorption, and other operations illustrate the course. Textbook: *Mass Transfer Operations* – 2nd Ed. R.E. Treybal

D. Mackay

651. CHEMICAL PLANT DESIGN

IV – 6 2 6 – –

The lectures take a systems approach to the design of chemical plant, proceeding from the origin through major design considerations to technical and economic feasibility. Considerations applying to overseas situations, and the relationship of design to operation are included. In the plant design laboratory teams of students design and evaluate a particular plant. Textbook: *Chemical Engineering Plant Design* – Vilbrandt and Dryden. Reference book: *Chemical Engineering Cost Estimation* – Aries and Newton.

M. Wayman, D. Mackay

652. CHEMICAL ENGINEERING LABORATORY

IV – 5c, 6 – 9 – –

A laboratory course to accompany subjects 631, 632, 650, and 651. Bench and pilot plant experiments are carried out to study a variety of unit operations such as fluidization, heat transfer, evaporation, filtration, distillation, extraction, and absorption.

Modern control instruments are discussed and operated. One laboratory report per week.

M. E. Charles and Staff in Chemical Engineering

653. PROCESS DYNAMICS

IV – 6 2 3 – –

The mathematical modelling of unsteady states in typical processes involving fluid flow, heat and mass transfer, vapor-liquid equilibria, and chemical reaction. Solution by analytical, analogue, and digital methods. Introduction to controller response modes.

D. Basmadjian, M. E. Charles, I. H. Spinner

654. ORGANIC CHEMISTRY

IV – 6 2 – 2 –

The Chemistry of the manufacture of natural and synthetic high molecular weight organic materials and the relation between molecular and submicroscopic structure and physical properties of rubbers, fibres, filaments, films and plastics.

W. H. Rapson

655. CHEMICAL ENGINEERING THERMODYNAMICS AND KINETICS

IV – 6 2 – 2 –

The application of thermodynamics and kinetics to problems in the field of chemical engineering.

W. H. Burgess, W. F. Graydon

656. PUBLIC SPEAKING

IV – 6 – – 2 –

Course 6, IV Year.

Staff in Chemical Engineering

660. ORGANIC CHEMISTRY

IV – 5c 2 – 1 –

A lecture course in organic chemistry, concluding with a section on the chemistry of high polymers.

H. L. Williams

661. ORGANIC CHEMISTRY LABORATORY

IV – 5c – – – 6

A laboratory course to accompany subject 660.

Z. May

662. PROCESS CONTROL

IV – 6 (elective) – – 2 –

Fundamentals to optimal control of engineering systems are developed from the state-

space viewpoint. The use of dynamic programming, maximum principle, and other optimization procedures is established and illustrated for both the continuous and discrete time systems. Non-linear analysis is introduced by approximate analytic methods, phase-space representation and the application of some elementary principles of asymptotology. Textbook: *Optimal Control of Engineering Processes* – Lapidus and Luus.

R. Luus

663. INSTRUMENTAL METHODS

IV – 6 (elective) – – 2 –

The subject is designed to emphasize the science of chemical instrumentation. The principles, technique, and applications of gas-chromatographic, opticometric, electrometric, and mass-spectrometric methods of analysis are studied.

S. Sandler

664. PROCESS DYNAMICS

IV – 5c 2 – 2 3

Analysis and control of chemical engineering systems with emphasis on non-linear methods; phase plane; Liapunov's method; averaging technique. Introduction to optimal control of processes; extraction train, distillation column, and chemical reactors.

R. Luus

665. THERMODYNAMICS AND STATISTICAL THERMODYNAMICS OF CHEMICAL SYSTEMS

IV – 5c 3 – – –

Development of the principles of chemical equilibrium and of statistical mechanics; application to both non-reacting and reacting systems, with emphasis on behaviour of multicomponent mixtures and complex reactions, and the calculation of thermodynamic properties in the ideal-gas state. Reference books: *The Principles of Chemical Equilibrium,* by K. G. Denbigh; *Introduction to Statistical Mechanics,* by G. S. Rushbrooke.

R. W. Missen

666. CHEMICAL ENGINEERING DESIGN

IV – 5c 2 6 2 6

Applications of heat transfer and fluid flow, mathematical modelling, and optimization in chemical engineering and chemical plant design. In the first term the laboratory is devoted to problems in these topics and in those of subject 665. In the second term, simultation and optimization are carried out for a particular chemical plant. Reference books: *Applied Mathematics in Chemical Engineering* – Mickley, Sherwood, and Reed. *Chemical Reactor Theory* – Denbigh. *Chemical Reaction Analysis* – Petersen.

J. W. Smith, M. E. Charles, M. Wayman, D. Mackay

667. DYNAMICS OF CHEMICAL SYSTEMS

IV – 5c – – 3 –

Elements of chemical rate process, complex chemical system dynamics, chemical

reactor stability. Application of analogue computers to the solution of problems in above topics.

I. H. Spinner

668. APPLIED NUCLEAR CHEMISTRY

IV – 6 (elective) – – 2 –

An introduction to the principles and methods of radioisotope chemistry. Applications of nuclear techniques and radioactive materials in chemical technology and in nuclear power generating systems. Topics to be covered include: radioisotype methods of studying chemical reaction mechanisms and kinetics; chemical process development and process control; nuclear reactions applied to chemical analysis (activation analysis); isotope separation; production of nuclear-grade materials such as uranium, plutonium, heavy water; chemical processing of irradiated reactor fuels; radioactive waste disposal; radiation chemical processing.

D. G. Andrews, R. E. Jervis

669. ADVANCED SEPARATION PROCESSES

IV – 6 (elective) – – 2 –

Theory and application of a number of separation processes, including multicomponent distillation (using computational techniques), azeotropic and extractive distillation, liquid extraction, transient behaviour and cyclic processes, thermal diffusion separations, and solid-liquid contacting operations. Illustrative design problems.

D. Mackay

670. NUCLEAR ENGINEERING

IV – 5nt 2 – 2 –

Nuclear engineering aspects of: nuclear constitution and properties including cross-section, energetics, radioactivity, production and use of radio-isotopes, neutrons, slowing down, "age" theory, diffusion of thermal neutrons, fission. The age and two-group theories of the reactor core. Reflected reactors (elementary treatment). Reactor kinetics, control and instrumentation. Applications of heat transfer, fluid flow and stress analysis to the reactor core. The measurement and control of radiation. Exposure of humans to radiation. Shielding techniques. Nuclear engineering applications of nuclear and radio-chemistry.

D. G. Andrews, R. E. Jervis

671. NUCLEAR ENGINEERING LABORATORY

IV – 5nt – 3 – 3

A laboratory course to accompany subject 670. Experiments are carried out with radiation sources and instruments, a sub-critical reactor, a reactor simulator, pulse height analyzers, fast neutrons generators and radioactive tracers.

D. G. Andrews, R. E. Jervis

DEPARTMENT OF ELECTRICAL ENGINEERING

700. ELECTRICITY

I – 1, 3, 4, 6, 7, 8, 9 — 2 ¾ 2 ¾

A basic course in electricity and magnetism including electric forces and fields, analysis of direct-current circuits, magnetic forces and fields, induction, and an introduction to the conductive, magnetic and dielectric properties of materials.

Staff in Electrical Engineering

701. ELECTRICITY

I – 5 — 2 – 2 –

A basic course in electricity and magnetism that is similar to subject 700 but adapted to the needs of Course 5.

Staff in Electrical Engineering

710. ELECTRIC CIRCUITS

II – 7 — 3 2 2 2

Linear lumped-parameter circuits as models for physical devices; relationships between circuit and field concepts. Transient response of simple circuits; natural and forced components of response. Response to complex-frequency excitation; impedance and admittance functions. Steady-state response of circuits with direct and sinusoidal sources. Loop and nodal analysis. General network theorems. Coupled circuits. Response of networks to variable-frequency excitation. Analysis of polyphase circuits; introduction to symmetrical components.

711. ELECTRIC AND MAGNETIC FIELDS

II – 7 — 2 2 2 2

Electric and magnetic fields, forces and energies associated with charged and current-carrying conductors embedded in dielectric and magnetic media. Particle dynamics in electric and magnetic fields. Time-varying fields in conductors and insulators. Development of Maxwell's equations and interpretation in static and dynamic situations.

S. D. T. Robertson

713. ELECTRICAL LABORATORY

II – 7 — – 3 – 3

Introduction to techniques of electrical measurement. Laboratory experiments to accompany subjects 710 and 711.

714. INTRODUCTORY ELECTRONICS

II – 7 — – – 2 1

Introduction to semiconductor physics. Physical principles of semiconductor and vacuum tube devices. Modelling and elementary circuit applications.

715. ELECTRIC CIRCUITS

II – 5 2 – 2 –

Circuits as models for physical devices. Kirchhoff's laws. Transient response of circuits. Steady-state response of circuits with sinusoidal excitation. Network theorems. Topology and loop and nodal analysis of general circuits. Complex frequency analysis of circuits. Response of circuits to variable-frequency excitation. Analysis of polyphase circuits. Magnetically coupled circuits.

V. G. Smith

716. ELECTRIC CIRCUITS LABORATORY

II – 5 – 1½ – 1½

Laboratory exercises to accompany subject 715.

717. CIRCUIT THEORY

II – 3 2 1½ – –

Introduction to linear circuit analysis. Phasor representation and the analysis of alternating-current circuits in the steady state. Magnetic circuits and transformers.

718. ELECTRICAL MEASUREMENTS

II – 3 – – 2 1½

Transducers for electrical measurement of non-electrical variables, and associated instrumentation. Errors. Analogue computation. Digital logic.

719. ELECTRICAL ENGINEERING

II – 4, 6, 8 2 – 2 –

Analysis of single-phase and three-phase circuits; principles of a-c and d-c machines; introduction to vacuum-tube and solid-state devices; basis of digital computation and analogue simulation; electronic measurements applied to industrial processes.

R. S. Segsworth, H. O'Beirne

720. ELECTRICAL LABORATORY

II – 4, 6, 8 – 3 – 3

Laboratory experiments and problems to accompany subject 719.

721. PROGRAMMING AND NUMERICAL METHODS

II – 7 2 – 1 –

Elementary numerical methods for systems of equations, iteration, integration, differential equations, roots, and random number generation, including a study of roundoff and truncation error. Basic computer structure and organization. Algorithms, procedures, and flowcharts. Discrete simulators and continuous simulators. Problems on Programming and Numerical Methods will be included in the computation periods associated with subjects 710 and 711.

724. ELECTRICAL ENGINEERING

II – 1 – – 2 –

Single and three phase sinusoidal sources, series and parallel combinations of linear circuit elements, transformers, electrical energy transducers applied to power and measurement. Principle of semiconductor devices.

730. PHYSICAL ELECTRONICS

III – 7 2 – 2 –

Introduction to solid-state physics and the theory of electron devices. Modelling and simple applications.

R. C. Cobbold

732. APPLIED MATHEMATICS

III – 7 2 2 2 2

Functions of a complex variable. Elementary probability theory and statistics.

733. LINEAR SYSTEM THEORY

III – 7 2 2 3 2

Correlation with orthogonal functions as a method of signal transformation. Fourier series, generalized Fourier and bilateral Laplace transforms; existence, uniqueness, and properties. Time-domain analysis; weighting functions, convolution, convolution algebra, similarity of correlation and convolution. Frequency-domain analysis; transfer functions, filter characteristics, pole-zero configurations. Frequency-domain convolution; time-varying systems and modulation. Matrix methods for multiple input-output systems; theory of linear two-port networks.

734. ELECTRIC MACHINERY I

III – 7 2 1 2 1

Processes of electromechanical energy conversion; modelling and analysis of magnetic devices and systems; transformers and saturable reactors; commutator machines; generalized polyphase machines; induction and synchronous machines; introduction to the control of electric machine systems.

G. R. Slemon

735. ELECTRICAL LABORATORY

III – 7 – 3 – 3

Laboratory exercises to accompany subjects 733 and 734.

737. ELECTRONIC CIRCUITS I

III – 7 – – 2 1

Application of electron devices in amplification and signal processing.

738. ELECTRONICS LABORATORY

III – 5a, 5cs, 5e, 5p – – – 3
IV – 5m – – – 3

Laboratory experiments to accompany subjects 730, 737 and 739.

739. PHYSICAL ELECTRONICS

III – 5a, 5cs, 5e, 5p 2 – 2 –
IV – 5m 2 – 2 –

A subject similar in content of that of 730 but adapted to the needs of Course 5.

S. Dmitrevsky

740. ELECTRONICS

III – 5c, 5g 2 – 2 –

Qualitative treatment of the physical principles of electron devices; analysis of idealized and basic practical rectifying and power-modulating circuits; some applications to systems.

K. C. Smith

741. ELECTRONICS LABORATORY

III – 5c, 5g – – – 1½

Laboratory experiments to accompany subject 740.

742. CIRCUIT ANALYSIS

III – 5cs, 5e, 5p 2 – 2 –

Advanced analytical methods are used to derive general network theorems and to discuss general network properties. Complex wave forms, filters and unbalanced poly-phase networks are considered in detail.

J. L. Yen

743. ELECTRONICS

III – 3 2 3 – –

Principles of electronics. Linear models of electronic devices. Amplifiers, oscillation and filters. Electronic circuits.

747. ELECTRONIC MACHINES

III – 3 – – 2 –

Principles of energy conversion. Transient operation of electromechanical systems. Electromechanical circuits. Rotating machinery.

750. FIELDS AND WAVES

III – 7 2 2 – –

Transient and steady-state analysis of transmission lines. Static and quasi-static fields. Plane waves.

751. THERMODYNAMICS AND STATISTICAL MECHANICS

III – 7 3 1 – –

Classical thermodynamics; first law, second law and entropy, thermodynamic potentials and their applications; chemical equilibrium, thermo-electric phenomena, radiation theory. Statistical mechanics; Boltzmann distribution and its limitations, Fermi-Dirac statistics and applications, Bose-Einstein statistics and Planck's Radiation Law. Theory of fluctuations; thermal noise, shot effect.

754. ELECTOMAGNETIC FIELDS

III – 5e, 5p 1 1 1 1

Transmission lines; static and quasi-static fields; applications of Maxwell's equations; plane waves; waveguides.

K. G. Balmain

760. SWITCHING THEORY

IV – 5cs, 7 2 1 – –

Boolean algebra. Boolean functions. Karnaugh and Quine-McCluskey minimization. Sequential machines. State minimization. State assignment. Relationship of sequential machines to switching components.

761. COMPUTER AND INFORMATION SYSTEMS

IV – 7 – – 2 1

Computer achitecture. Software systems and hardware systems and their interdependencies. Kinds of systems. Real-time systems. Data-base organizations. Details of supervisory systems. Syntactic analysis and meta languages. List processing. Sorting and merging data.

762. ELECTROMAGNETIC THEORY

IV – 7 2 1 – –

Maxwell's equations, wave equations, retarded potentials, reciprocity theorem, plane waves.

763. ELECTRIC MACHINERY II

IV – 7 2 – – –

The structure, field analysis and modelling of generalized polyphase machines; induction and synchronous machines; behaviour under unbalanced conditions; single-phase machines and alternating current control motors.

A. Straughen

764. ELECTRIC MACHINES LABORATORY

IV – 7 – 3 – –

Laboratory exercises to accompany subject 763.

765. CONTROL SYSTEMS

IV – 7 2 – 2 –

A study of the analysis and synthesis of linear feedback control systems by means of differential equations and the Laplace transform. Topics covered include stability criteria, root-locus methods and compensation methods. An introductory study of non-linear systems is also made, including the use of describing-function and phase-plane methods of analysis.

H. W. Smith

766. SYSTEM DYNAMICS

IV – 5a, 5e 2 – 2 –

A study of the analysis and synthesis of linear feedback control systems by means of differential equations and the Laplace transform. Topics covered include stability criteria, root-locus methods and compensation methods. An introductory study of non-linear systems is also made, including the use of describing-function and phase-plane methods of analysis.

I. McCausland

767. CONTROL SYSTEMS LABORATORY

IV – 7 – 1½ – 1½

Laboratory experiments to accompany subject 765.

768. ELECTRONIC CIRCUITS II

IV – 7 3 – – –

Primarily dealing with the applications of semiconductors to small signal amplifiers stressing design techniques. Oscillators, modulators, and demodulators; pulse circuits.

G. W. Dick

769. ELECTRONIC CIRCUITS LABORATORY

IV – 5a, 5cs, 5e, 5p – – – 3

IV – 7 – 3 – –

Experiments and problems to accompany subjects 768 and 778.

770. COMMUNICATION SYSTEMS

IV – 7 – – 3 –

An introduction to the analysis and design of systems for transmitting information.

G. R. Lang

771. COMMUNICATIONS LABORATORY

IV – 7 – – – 1

Experiments and problems to accompany subject 770.

772. NETWORK THEORY

IV – 7 – – 2 1

The basis of network analysis; differential equations, s-plane representation, steady state, transients, transfer functions, two-port parameters, insertion loss, the synthesis problem. The positive-real concept of Brune; positive-real testing, stability testing, synthesis of RLC one-terminal pairs (Brune), reactance functions. Two-port synthesis, positive real matrix, residue condition, symmetric lattice, ladder network synthesis (single and double termination).

773. SYSTEMS DYNAMICS LABORATORY

IV – 5a, 5e – 1½ – 1½

Laboratory experiments and problems to accompany subject 766.

774. ELECTRIC MACHINERY III

IV –7 – – 2 –

Nonlinear power modulators, transient performance of induction and synchronous machines; reluctance, commutator and control machines.

A. Straughen

775. ELECTRIC MACHINES LABORATORY

IV – 7 – – – 1½

Laboratory exercises to accompany subject 774.

776. RADIATION AND PROPAGATION

IV – 7 – – 2 1½

Waveguides, antenna arrays, aperture antennas, noise properties of antennas.

778. ELECTRONIC CIRCUITS

IV – 5a, 5cs, 5e, 5p 2 – 1 –

A course similar to subject 768 but adapted to the needs of Course 5.

G. W. Dick

779. ELECTRIC POWER SYSTEMS

IV – 7 – – 3 –

Engineering aspects of the economic generation, transmission and distribution of electrical energy in bulk and the control of power systems under normal and fault conditions.

W. Janischewskyj

780. ELECTRIC POWER SYSTEMS LABORATORY

IV – 7 – – – 3

Laboratory exercises and problems, to accompany subject 779.

782. INFORMATION SYSTEMS I

IV – 5cs, 5e 2 – 1 –

The analysis and design of information systems and components, noise, information and signal theory.

G. Lang

783. INFORMATION SYSTEMS LABORATORY

IV – 5cs, 5e – – – 3

Experiments and problems to accompany subjects 782 and 786.

S. Dmitrevsky

784. QUANTUM ELECTRONICS

IV – 7 – – 2 1

Schroedinger equation and simple applications. Quantum Statistics. Theory of susceptibility. Masers.

785. QUANTUM ELECTRONICS PROBLEMS

IV – 7 – – – 1½

Problems associated with subject 784 worked out and discussed under staff supervision.

786. INFORMATION SYSTEMS II

IV – 5cs, 5e – – 2 –

The study of digital information processing including the coding of data, and the design of logic circuits and switching systems.

G. W. Dick

787. TECHNIQUES OF OPTIMIZATION

IV – 5cs 2 3 2 3

Linear and non-linear mathematical programming; dynamic programming; queueing theory; some problems in control theory; Monte Carlo methods. Applications will be drawn from Engineering practice.

788. ENERGY CONVERSION PROCESSES

IV – 5e 2 – 2 –

Energy conversion phenomena, magnetic materials, modelling and analysis of magnetic devices including transformers, commutator and polyphase machines, solid-state converters. Electro-magnetic force and fluid interactions.

S. D. T. Robertson

789. ENERGY CONVERSION LABORATORY

IV – 5e – 1½ – 1½

Investigations and projects related to subject 788.

790. WAVE THEORY

IV – 5e, 5p 2 – 3 –

Mechanical and electromagnetic waves in one dimension for transient and steady state conditions. Guided waves. Radiation. Interaction of waves with matter.

K. Balmain

791. WAVE LABORATORY

IV – 5e – 3 – –

Supplementing course number 790.

792. ACOUSTICS

IV – 7 – – 2 1½

The properties of acoustical elements and their application in electrical sound systems.

V. L. Henderson

794. ILLUMINATION

IV – 7 – – 2 1½

Nature, measurement and production of light and related radiations. Theory of human vision; consideration of environmental design requirements related to light and vision for optimum visual efficiency and comfort.

Miss M. G. Currie

795. POWER SEMICONDUCTOR CIRCUITS

IV – 7 – – 2 1½

Principles of thyristor devices. Study of inverter, convertor and rectifier circuits with particular applications to DC and AC motor speed control and frequency conversion.

796. BIOMEDICAL ENGINEERING

IV – 7 – – 2 1½

Interaction between engineering and medicine; biological examples of important engineering concepts; instrumentation.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

801. PHYSICAL CHEMISTRY

II – 8 2 – 1 –

A course on basic physico-chemical properties of matter with emphasis on kinetic theory of gases, phase relationships and transformations.

S. N. Flengas, J. M. Toguri

802. CHEMICAL METALLURGY

III – 5m, 8 2 – – –

A fundamental treatment of the metallurgical processes involved in the production of the important non-ferrous metals, including oxidation of sulphides in the liquid and solid states, reduction of oxides, matte-slag equilibrium, metal-slag equilibrium, and the distillation of metals.

L. M. Pidgeon

803. CHEMICAL METALLURGY LABORATORY

III – 8 – 3 – 6

Experiments in materials processing, including roasting, smelting, leaching, refining, electrolysis to accompany subjects 802 and 833. Eight laboratory reports per term.

H. U. Ross

804. METALLURGY

III – 9 – – 2 –

An introductory course describing the theory and practice of metallurgical processes and operations.

H. U. Ross

805. CHEMICAL METALLURGY

IV – 5m, 8 3 – 3 –

The extractive metallurgy of iron, steel, and the reactive metals.

L. M. Pidgeon, H. U. Ross, J. M. Toguri

806. CHEMICAL METALLURGY LABORATORY

IV – 8 – 6 – –

Experiments in the extraction and refining of metals and related processes to accompany subject 805. Six laboratory reports per term.

H. U. Ross

808. METALLURGY

IV – 9 1 – 1 –

The extractive metallurgy of the common metals, together with the calculations necessary to understand metallurgical processes.

L. M. Pidgeon

810. THERMODYNAMICS IN METALLURGY

III – 8 2 – 2 –

A study of chemical equilibria at high temperatures in extractive metallurgy – slag metal reactions – classical theory of solutions – phase transformations – thermodynamic relationships in phase diagrams.

S. N. Flengas

812. METALLURGICAL PROBLEMS LABORATORY

III – 8 – 4 – 4

Problems in chemistry, physical chemistry and thermodynamics as applied to metallurgical processes, and solid state reactions relating to subjects 802 and 810.

S. N. Flengas, H. U. Ross

813. PHYSICAL CHEMISTRY OF MATERIALS

IV – 8 – – 2 –

Electrochemistry of solids, liquids, and of high temperature systems. Fused salt electrochemical cells. Thermodynamics of imperfections and properties of ionic solids.

S. N. Flengas

814. METALLURGICAL PROBLEMS LABORATORY

IV – 8 – 2 – 2

Problems relating to subjects 805 and 813.

L. M. Pidgeon, H. U. Ross, J. M. Toguri

815. PHYSICAL METALLURGY

II – 1 – – 2 –

A course on the structure and mechanical properties of metals and alloys and on the influence of heat and mechanical treatment upon these properties. Reference is made particularly to steels and the more-important non-ferrous alloys. Welding of metals is also included.

K. T. Aust

816. PRINCIPLES OF METALLOGRAPHY

II – 8 1 3 – –

A discussion of the framework of metallographic practice, dealing with optical, x-ray, electron and field-ion microscopy applied to a wide range of materials. Topics covered include the optics of microscopy and diffraction; the use of polarized light, phase contrast and interferometry; specimen preparation methods; applications of quantitative metallography.

W. A. Miller

819. PHYSICS OF METALS

III – 7 – – 2 –

A course on physics of metals to include structure of solids, defect structures, diffusion, electron theory, phase transformations, and the effect of stress and temperature upon metals.

U. M. Franklin

820. PHYSICS OF METALS LABORATORY

III – 7 – – – 1½

Experiments are conducted to illustrate the essential features of subject 819. These in-

clude the examination of metals by metallographic and X-ray diffraction techniques.

Staff in Metallurgy and Materials Science

821. PHYSICS OF METALS

III – 5m, 8 2 – 2 –

A discussion of the structure of solids with particular reference to X-ray methods of investigation; physical and mechanical properties of solids; diffusion.

G. B. Craig, B. Ramaswami

822. PHYSICS OF METALS LABORATORY

III – 5m, 8 – 6 – 3

Practical work relating to subject 821.

U. M. Franklin, W. A. Miller

823. PHYSICS OF METALS

IV – 5m, 8 4 – 4 –

Thermodynamics and kinetics of phase transformations in metals and alloys.

K. T. Aust, G. B. Craig, B. Ramaswami, J. W. Rutter

824. PHYSICS OF METALS LABORATORY

IV – 5m, 8 – 3 – 3

Practical work relating to subject 823.

G. B. Craig

826. MATERIALS SCIENCE SEMINAR

IV – 5m, 8 – 3 – 3

Each student prepares and presents seminars on topics concerning chemistry and physics of materials.

Staff in Metallurgy and Materials Science

827. MATERIALS SCIENCE LABORATORY

IV – 5m – 12 – 12

The design and execution of one or more experiments on a topic of current interest in the field of chemistry and physics of materials.

Staff in Metallurgy and Materials Science

829. CHEMISTRY OF METALS LABORATORY

III – 5m – – – 3

Experiments designed to illustrate the principles underlying the high temperature reactions which are encountered in the production and refining of metals.

H. U. Ross

830. METALLURGICAL THERMODYNAMICS

III – 5m 1 – 1 –

Chemical equilibria at high temperatures in extractive metallurgy. Condensed states of matter – quasichemical approach to the theory of solutions – slag theories – metallic solutions – slag/ metal equilibria – kinetics of metallurgical processes.

S. N. Flengas

831. METALLURGICAL THERMODYNAMICS PROBLEMS

III – 5m – 2 – 2

Problems relating to subject 830.

S. N. Flengas

832s. MATERIALS SCIENCE

II – 8 2 – 2 –

III – 5m 2 – 2 –

A course on the structure and properties of plastics, glass, ceramics, semi-conductors, and concrete.

Staff in Chemical Engineering, Civil Engineering, Electrical Engineering, Metallurgy and Materials Science

833. MATERIALS PROCESSING

III – 8 2 – 1 –

The theory and practice of processing metallic and non-metallic materials, including the relevant aspects of mineralogy, surface chemistry, physical separation, calcining, roasting, sintering and leaching.

H. U. Ross

834. MATERIALS SCIENCE

II – 3 2 – 2 1½

II – 4 2 – 2 3

A discussion of the effects of microscopic and atomic structures on the electrical, chemical and mechanical properties of engineering materials. The topics covered include atomic bonding, structures of ideal and real crystals, phase transformations and diffusion, chemical and mechanical properties, and oxidation and corrosion phenomena. The laboratory experiments will include x-ray studies of crystal structure; measurement of resistivity and magnetism of selected solids; study of various alloy phases and transformations; study of dislocation patterns, stress-strain relationships, stress-relaxation and fatigue phenomena; study of oxidation and corrosion reactions.

G. B. Craig, B. Ramaswami

835. MATERIALS SCIENCE I

II – 7 2 1½ 2 1½

The electrical, mechanical and chemical properties of engineering materials will be

related to their atomic and microscopic structures. Atomic bonding, crystal structure, defect structures, introductory thermodynamics of solids, diffusion, crystal growth, solidification and zone refining; stress, strain and shear relations for elastic and plastic deformation of various isotropic and anisotropic materials; effect of annealing on microstructure and on mechanical and physical properties; fatigue, creep and fracture. The laboratory experiments are designed to relate structure to mechanical and physical properties in engineering materials. X-ray studies, plastic deformation, annealing, precipitation hardening, phase diagrams, casting solidification, diffusion, measurement of elastic and plastic stress-strain relations for different materials, heat treatment of steel, properties of polymers, measurement of electrical resistivity.

Staff in Metallurgy and Materials Science

836. REACTION KINETICS

IV – 8 2 – – –

Kinetics of heterogeneous reactions. Diffusion controlled processes. Imperfections in solids. Fick's laws of diffusion. Application of theory to metallurgical operations.

J. M. Toguri

INSTITUTE FOR AEROSPACE STUDIES

1028. FLUID MECHANICS

III – 5a 2 – 1 –

Introductory concepts and idealizations of real fluids; mathematical theory of incompressible inviscid flow; viscous flow and turbulence. Reference books: *Fundamentals of Hydro and Aeromechanics* – Prandtl and Tietjens; *Applied Hydro and Aeromechanics* – Prandtl and Tietjens; *Fluid Dynamics* (1948 ed.) – Streeter. Advanced reading: *Hydrodynamics* – Lamb; *Incompressible Aerodynamics* – Thwaites; *An Introduction to Fluid Dynamics* (1967) – Batchelor.

H. S. Ribner

1029. FLUID MECHANICS LABORATORY

III – 5a – 3 – 1½

Problems and experiments related to subject 1028. Seven laboratory reports.

H. S. Ribner, P. A. Sullivan

1030. ADVANCED MECHANICS

III – 5a, 5e, 5g, 5m, 5nt, 5p 2 – 2 –

Mechanics of particles: fixed axes, rotating and moving axes, orbital dynamics, rockets. Mechanics of rigid bodies: fixed axes, body-attached axes, gyroscopes. Mechanics of linear systems: free and forced oscillations, coupled systems, waves on a string. Rayleigh's method. Lagrange's equations. Introduction to special relativity. Reference

books: *Principles of Dynamics* – D. T. Greenwood. *Principles of Mechanics* – Synge and Griffith. *Dynamics,* Vols. I and II, Halfman.

S. J. Townsend

1034. MECHANICS OF STRUCTURES

III – 5a 2 – 2 –

Basic theorems and principles in the theory of structures (strain energy, virtual displacements, minimum total potential energy). General theory of bending of beams (unsymmetrical bending, thin walled structures, shear flow in multiflanged beams, open and closed sections). General theory of torsion (thin walled structures, multi-cell structures, shear centre). Theory of elastic instability (buckling of slender elastic struts, flat and curved plates, shells). Plane stress problems (Airy and Prandtl stress functions).

R. C. Tennyson

1035. MECHANICS OF STRUCTURES LABORATORY

III – 5a – 1½ – 3

Problems and experiments relating to subject 1034. Five laboratory reports.

R. C. Tennyson

1040. AERODYNAMICS

IV – 5a 2 – 2 –

Aerodynamics of flight: drag, propulsion, wing theory. Mechanics of flight: performance of aircraft, stability and control of aircraft. Reference books: *Aerodynamics of V/STOL Flight* – B. W. McCormick, Jr. *Foundations of Aerodynamics* – Kuethe and Schetzer. *Flight Mechanics – 1: Theory of Flight Paths* – A. Miele. *Dynamics of Flight – Stability and Control* – Etkin.

L. D. Reid

1041. AERODYNAMICS LABORATORY

IV – 5a – 1½ – 1½

Problems and experiments related to subject 1040. Six laboratory reports.

L. D. Reid

1042. PHYSICS OF RADIATING GASES

IV – 5a 2 – 2 –

Review of atomic and spectroscopic theory, line radiation, Einstein coefficients, optical depth, population inversion and lasers, Doppler and pressure broadening, vibration and rotation of molecules, local thermodynamic equilibrium, methods, of determining the temperature and electron number density of high temperature gases.

R. M. Measures

1043. ENGINEERING DESIGN

IV – 5a – 6 – 3

A number of multidisciplinary engineering design projects are carried out by the student under the supervision of staff and of experienced design engineers from industry. Drawings and reports are prepared as required.

G. K. Korbacher

1044. PHYSICS AND MECHANICS OF SOLIDS

IV – 5a 2 – 2 –

Properties of solids, their dependence on atomic bonding, atomic and molecular structure. Structural imperfections and atom movements. Deformation and failure of metals. Multiphase materials and phase relationships. Modification of properties through microstructural changes. Environmental effects on service life. Physics of surface protection. Technology of non-destructive testing. Reference books: *Elements of Materials Science* – Van Vlack. *Inelastic Behaviour of Engineering Materials and Structures* – Freudenthal.

G. K. Korbacher

1045. PHYSICS AND MECHANICS OF SOLIDS LABORATORY

IV – 5a – 1½ – 3

Problems and experiments related to subject 1044. Six laboratory reports.

G. K. Korbacher

1046. PLASMADYNAMICS

IV – 5a 2 – 2 –

Maxwell's equations, concept of a plasma, motion of charged particles, introduction to confinement and stability, plasma equations of motion and conduction, simple examples of waves and flow problems in magnetogas dynamics, applications to propulsion and power generation, radiation from plasmas, diagnostics of plasmas.

J. H. DeLeeuw, R. M. Measures

1047. PLASMA DIAGNOSTICS LABORATORY

IV – 5a – 1½ – 1½

Probe and spectroscopical studies of a low pressure discharge and a magnetic shock tube plasma. Three laboratory reports.

R. M. Measures, S. J. Townsend

1048. GASDYNAMICS

IV – 5a 2 – 2 –

Introductory thermodynamics of perfect and imperfect gases; equations of motion and their applications to nozzles, diffusers, shock tubes, and shock tunnels; expansion waves and normal and oblique shock waves in perfect and imperfect gases; shock and expan-

sion wave interactions; three-dimensional flows. Reference books: *Elements of Gasdynamics* – Liepmann and Roshko. *Dynamics and Thermodynamics of Compressible Fluid Flow* – Shapiro. *Handbook of Supersonic Aerodynamics, Section 18, Shock Tubes* – Glass and Hall. *Introduction to Physical Gasdynamics* – Vincenti and Kruger.

I. I. Glass

1049. GASDYNAMICS LABORATORY

IV – 5a – 1½ – 3

Problems and experiments based on subject 1048 are given to illustrate principles of gasdynamics and the measurement of physical quantities. Six laboratory reports.

P. A. Sullivan

1050. TRANSPORT PHENOMENA

IV – 5a – – 2 –

A fundamental treatment of selected phenomena in fluid dynamics in which the transport of momentum, mass and energy are the key underlying processes, i.e. dynamics of viscous fluids; boundary layers; diffusion. Reference book: *Transport Phenomena* – Bird, Stewart and Lightfoot.

J. B. French

DEPARTMENT OF PHILOSOPHY

2040. PHILOSOPHY AND SCIENCE

IV – All courses 2 – – –

The relation between Science and Philosophy; and examination of the presuppositions of science and its basic concepts; alternative accounts of the implications of science for social, moral, and religious conceptions.

P. M. Churchland

DEPARTMENT OF ENGLISH

2110. ENGLISH

I – All courses 2 – 2 –

A course in essay writing and the reading of literary works. Texts will include: Twain, *Huckleberry Finn* (Riverside or Chandler); Camus, *The Stranger* (Vintage); Warren and Erskine (eds.), *Short Story Masterpieces* (Dell); Shakespeare, *Antony and Cleopatra* (Arden); one other nvoel, two other plays, and a poetry anthology to be announced in September. Another novel and play may be added at the discretion of the instructor. Students must complete satisfactorily all assignments, including class tests, given them by their instructor. It should be noted that the final mark for the year is the average of the term mark and the examination mark.

2140. ENGLISH LITERATURE

IV – All courses 1 – 1 –

A course in the drama, the novel and poetry based on the study of the following texts: Brecht, *Galileo* (Methuen); Williams, *A Streetcar Named Desire* (Signet); Miller, *The Crucible;* Crane, *The Red Badge of Courage;* Greene, *The Power and the Glory* (Penguin); Golding, *The Lord of the Flies* (Penguin); Oscar Williams (ed.), *Immortal Poems of the English Language* (Washington Square). Students are expected to read the works named above during the summer preceding their entry into the Fourth Year. Term work will include a class test on these works to be given in the second lecture period of the year, one substantial essay, and one or two further class tests at the discretion of the instructor.

DEPARTMENT OF HISTORY

2330. THE HISTORY OF TECHNOLOGY AND ENGINEERING

III – All courses (elective) 2 – 2 –

An historical treatment of the development of tools, techniques, and relevant skills from their inception processes will be considered along with the interplay with contemporary society. Historical points of contact with theoretical and scientific thought will be examined. The accomplishments, influence, and role of the engineer will be traced from antiquity to current society.

J. W. Abrams

2332. EUROPE AND THE MODERN WORLD, 1500-1950

III – All courses (elective) 2 – 2 –

An introduction to the main currents of European history between 1500 and 1950, and of European relations with the extra-European world. The purpose of the course is not merely the accumulation of factual information, but also the attainment of some understanding of historical processes affecting the forms of political organization, economic activity, intellectual and social movements. Textbook: E. R. Tannenbaum, *European Civilization Since The Middle Ages* (John Wiley).

J. Dent

DEPARTMENT OF MATHEMATICS

2410s. ALGEBRA AND ANALYTIC GEOMETRY

I – 1, 3, 4, 6, 7, 8, 9 2 1 2 1

Introduction to linear algebra with applications to three dimensional euclidean geometry. Matrix algebra and the solution of linear systems of equations. Determinants. Reduction of quadrics to standard form.

Staff in Mathematics and Staff in Engineering

2411s. CALCULUS

I – 1, 3, 4, 6, 7, 8, 9 2 1 2 1

The theory of the derivative. Applications to curve sketching, rate problems and extremal problems. The definite integral. Volume and work calculations. Techniques of integration.

Staff in Mathematics and Staff in Engineering

2415s. ALGEBRA AND GEOMETRY

I – 5 2 1½ 2 1½

Complex numbers and fields. Polynomials. Linear Algebra: linear equations, vector spaces and linear transformations. Co-ordinate Geometry: lines, planes and surfaces of the second degree.

W. J. R. Crosby, R. Luus

2416. CALCULUS

I – 5 2 1½ 2 1½

An introduction to the theory and applications of differential and integral calculus. Reference books: *Calculus* – Sherwood and Taylor. *Calculus,* Vol. I – Apostol.

E. Prugovecki, P. Rosenthal

2420s. CALCULUS

II – 1, 3, 4, 6, 8, 9 2 1 2 1

Continuation of subject 2410. Partial differentiation, multiple integration, series and Taylor's theorem, complex numbers and hyperbolic functions, first order differential equations and higher order linear differential equations with constant coefficients.

M. A. Ackoglu, H. Radjavi, J. Williams, D. J. L. Kennedy

2421. CALCULUS AND DIFFERENTIAL EQUATIONS

II – 7 2 2 2 2

The definite integral, expansion in series, ordinary differential equations, partial differentiation, multiple integration and an introduction to partial differential equations.

P. C. Greiner

2422. PROBABILITY AND STATISTICS

II – 3 2 1 – –

Probability Concepts: Independent and conditional events, discrete and continuous frequency distributions, moments and generating functions. Sampling: randomness, samples from populations, central limit theorem, transformation of variables, levels of significance. Tests of hypotheses.

J. B. Whitney

2423. PROBABILITY AND STATISTICS

II – 4, 8 2 – 2 –

Frequency distributions and probability laws; binomial, Poisson, and normal distribu-

tions and the treatment of samples drawn from them; tests of significance and confidence limits; control charts; introduction to the analysis of variance; design of experiments; regression theory.

A. E. Paull

2424. PROBABILITY AND STATISTICS LABORATORY

II – 4, 8 – 2 – 2

Laboratory exercises associated with the material of the companion lecture subjects.

2425. CALCULUS

II – 5 3 2 3 2

Ordinary and partial differentiation, differentials. Taylor's theorem for functions of one or more variables, maxima and minima, transformations, convergence and uniform convergence, differential equations of the first order, linear differential equations with constant coefficients, methods of indefinite integration, definite integrals, multiple integrals, line and surface integrals, orthogonal functions. Textbooks: *Advanced Calculus* – Sokolnikoff. *Advanced Calculus* – Taylor.

2427. PROBABILITY AND STATISTICS

II – 5 – – 3 2

Definition of probability; binomial, Poisson, and normal distributions; frequency; sampling distributions. Examples of estimation, hypothesis testing, control charts, regression, and analysis of variance.

R. Wormleighton

2429. NUMERICAL METHODS

II – 5 3 2 – –

Non-linear equations, matrix calculations, quadrature, and ordinary differential equations.

R. L. Johnston

2430. PROBABILITY AND STATISTICS

III – 4 1 – 1 –

A continuation of course 2423. General regression theory; elements of the theory of sample surveys; an introduction to the theory of stochastic processes.

H. Levenbach

2431. PROBABILITY AND STATISTICS LABORATORY

III – 4 – 1½ – 1½

Laboratory exercises based on the material of course 2430.

H. Levenbach

2432. DIFFERENTIAL EQUATIONS

III – 4, 8, 9 2 – 2 –

First and second order ordinary differential equations, operational methods, variation of parameters, solution in series, Fourier series, Bessel and Legendre functions, the Laplace transform.

N. A. Derzko, W. R. S. Sutherland

2433. NUMERICAL ANALYSIS

III – 4 2 – 2 –

Solution of algebraic equations, systems of linear equations, eigenvalue problems, interpolation, approximation theory, numerical integration, random numbers. Reference texts: *An introduction to Numerical Mathematics* – E. L. Stiefel. *Methods in Numerical Analysis* – Kaj L. Nielsen. *Numerical Methods for Science and Engineering* – R. G. Stanton.

W. K. Hastings

2434. NUMERICAL ANALYSIS LABORATORY

III – 4 – 3 – 3

Practice in the numerical analysis methods and techniques dealt with in the lecture subject. Practical problems, as well as problems of a fundamental mathematical nature, will be covered.

N. Stewart

2437. THEORY OF FUNCTIONS

III – 5 2 – 2 –

Complex numbers, limits and series, analytic functions, Cauchy's theorem, Taylor and Laurent series, singularities and their significance, analytic continuation, contour integration, conformal mapping of one plane region on another. Textbooks: *Functions of a Complex Variable* – Phillips. *Theory of Functions* – Copson. *Theory of Functions as Applied to Engineering Problems* – Rothe, Ollendorf, and Pohlhausen. *Introduction to Complex Variables and Applications* – Churchill.

F. V. Atkinson

2438. DIFFERENTIAL EQUATIONS

III – 5 2 – 2 –

First order equations solvable by quadratures, the linear equation of general order, operator methods, simultaneous linear equations, Sturm-Liouville systems, numerical methods. Textbook: *Ordinary Differential Equations* – Kaplan.

H. Dachslager

2440. NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

IV – 5cs 2 – 2 –

The numerical solution of parabolic, hyperbolic and elliptic partial differential equations.

2445. DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS

IV – 5 2 – 2 –

Linear partial differential equations of second order, Green's functions, distributions, eigenvalues and eigenfunctions with applications to wave propagation, heat flow and boundary value problems. Textbook: *Differential Equations of Applied Mathematics* – Duff and Naylor.

G. F. D. Duff

DEPARTMENT OF PHYSICS

2501. THE STRUCTURE AND PROPERTIES OF MATTER

I – 1, 3, 4, 6, 7, 8, 9 2 1½ 2 1½

An introduction to the mechanical, electrical, magnetic, thermal and optical properties of matter in terms of atoms.

R. J. Balcombe, M. Fowler, P. A. Griffin, C. O. Hines, B. P. Stoicheff

2511. PROPERTIES OF MATTER, MECHANICS AND HEAT

I – 5 3 – 3 –

Textbook: *Elementary Classical Physics – Vol. 1* – Weidner and Sells.

D. G. Ivey

2512. PHYSICS LABORATORY

I – 5 – 4 – 4

To accompany subject 2511.

D. G. Ivey and the staff in Physics

2521. PHYSICS

II – 5 3 – 3 –

Fundamental theory of electricity and magnetism. Electromagnetic waves. Interference, diffraction and polarization of light waves. Elementary atomic physics.

J. N. P. Hume

2522. PHYSICS LABORATORY

II – 5 – 3 – 3

To accompany subject 2621.

J. N. P. Hume

2531. STATISTICAL PHYSICS

III – 5a, 5cs, 5e, 5g, 5nt, 5p 2 – – –

The fundamental principles of thermodynamics, kinetic theory and statistical mechanics.

J. V. Iribarne

2532. PHYSICS LABORATORY

III – 5a, 5e, 5g, 5nt, 5p – 3 – 3

To accompany subjects 2531, 2533 and 2534.

J. C. Stryland

2533. ATOMIC STRUCTURE AND QUANTUM PHYSICS

III – 5a, 5cs, 5e, 5g, 5nt, 5p – – 4 –

Waves and particles; Schrodinger equation; harmonic oscillator, hydrogen atom, many-electron atoms; nuclear structure; radioactivity; interaction of radiation with matter.

A. E. Litherland

2534. PHYSICS OF SOLIDS AND FLUIDS

III – 5e, 5g, 5m, 5p 1 – 1 –

Elasticity, viscosity, equations of fluid motion, wave propagation, heat conduction, potential theory.

R. List

2537. ASTRONOMY AND GEOPHYSICS

III – 5g 2 – 2 –

A survey of astronomy – stars and stellar systems; an introduction to terrestrial and atmospheric Physics.

P. R. Demarque, A. W. Brewer, D. York, J. T. Wilson

2538. GEOPHYSICS

III – 5g – 2 – 2

Reading and essay assignment to accompany course 2537.

G. D. Garland

2539. GEOPHYSICS LABORATORY

III – 5g – 3 – –

A problem laboratory treating the mathematical computational methods of linear systems analysis applicable to geophysics.

G. F. West

2541. ELECTROMAGNETIC RADIATION AND MATTER

IV – 5p 4 – – –

Propagation of electromagnetic waves, polarization, diffraction, interference, dispersion, scattering. Absorption, spontaneous and stimulated emission, Einstein coefficients. Coherence, maser and laser action.

H. L. Welsh, R. A. Armstrong

2542. PHYSICS LABORATORY

IV – 5nt – 3 – 3
IV – 5p – 6 – 6

To accompany the lecture subjects 2541, 2544 and 2545.

The Staff in Physics

2543. MOLECULAR PHYSICS AND STATISTICAL MECHANICS

IV – 5p 4 – – –

Quantum theory of rotation and vibration of molecules. Nuclear spins, symmetry, intensity rules, the hydrogen molecule, intermolecular forces. Boltzmann theory, transport equations, the Gibbs method, partition functions.

E. J. Allin and J. D. Poll

2544. NUCLEAR AND HIGH ENERGY PHYSICS

IV – 5nt, 5p – – 4 –

Nuclear forces, alpha-decay, beta-decay. Excited states of nuclei. Nuclear models. Reaction theory. Mesons, anti-particles, hyperons.

K. G. McNeill, J. D. Prentice

2545. QUANTUM MECHANICS

IV – 5e, 5p 2 – 2 –

Schrodinger equation, eigenvalues and eigenfunctions. Angular momentum, Pauli spin theory, identical particles. Perturbation theory, tansition probabilities. Scattering theory.

J. W. Moffat

2546. SOLID STATE PHYSICS

IV – 5p – – 4 –

Crystal structure and lattice vectors, lattice energy, elastic constants. Heat capacities (Einstein, Debye, Born and Von Karman). Reciprocal lattice, order-disorder transitions. Electron theory of metals, energy bands. Brillouin zones, electrical and thermal conductivity. Semi-conductors, electron and hole conduction, rectifier and transistor action. Magnetism, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrites.

G. M. Graham, J. Van Kranendonk

2547. RELATIVITY THEORY

IV – 5p 2 – 2 –

Galilean invariance, experiments of Hoek, Fizeau and Michelson, the principle of relativity and of the constancy of the velocity of light. Relativistic kinematics, inertial frames, Lorentz transformations, covariance of Maxwell's equations. Relativistic dynamics, proper time energy and momentum, equivalence of mass and energy. General theory of relativity, principle of equivalence, non-Euclidian geometry, geodesics, propagation of light in a gravitational field.

C. Barnes, J. D. Scott

2561. THEORY AND APPLICATION OF GEOPHYSICAL METHODS

IV – 5g 2 – 2 –

A course on the mathematical theory of magnetic, electrical, seismic and gravitational methods in applied geophysics. Reference: Grant and West, Interpetation Theory in Applied Geophysics.

F. S. Grant

2568. EXPLORATION GEOPHYSICS

IV – 9 2 – 2 –

An introduction to the physical principles underlying the important methods of geophysical prospecting. Particular attention is given to the seismic, gravitational, magnetic and electromagnetic methods. References: Dobrin, Introduction to Geophysical Prospecting; Parasnis, Mining Geophyiscs.

G. F. West

2569. GEOPHYSICS

IV – 9 – 3 – 3

To accompany subject 2668.

R. M. Farquhar

2570. PHYSICS OF THE EARTH

IV – 5g 2 – 2 –

Seismology and the internal constitution of the earth; the gravitational field; the earth's magnetism and magnetic properties of rocks; radioactivity, geothermal heat and the age of the earth. Reference: Coulomb and Jobert, the Internal Constitution of the Earth.

G. D. Garland, J. C. Savage

2571. ATMOSPHERIC PHYSICS

IV – 5g 2 – 2 –

Meteorological measurements, radiation, atmospheric statics and conditions for equilibrium, atmospheric thermodynamics, equations of motion, synoptic charts, the general circulation, condensation physics, atmospheric electricity. Wind structure near the ground, evaporation, the stratosphere.

A. W. Brewer

2572. SOLIDS WITHIN THE EARTH

IV – 5g 2 – 2 –

The theory and experiments which are pertinent to the mechanical, thermal, and electrical properties of matter at the pressures and temperatures which obtain within the earth.

J. C. Savage

2573. GEOPHYSICS LABORATORY

IV – 5g – 6 – 9

A laboratory course stressing experimental and mathematical techniques applicable to the geophysical sciences.

F. S. Grant, G. F. West

2574. TECTONOPHYSICS

IV – 5g 2 – 2 –

An examination of the several physical theories proposed for the behaviour of the earth, in terms of seismic, geothermal isotopic, palaeomagnetic and other geophysical and geological observations made over ocean basins, islands and continents.

J. T. Wilson

2624. ANALYTICAL CHEMISTRY

II – 8 1 3 1 3

Theory of quantitative separations and instrumental analysis. Aqueous solution chemistry.

J. A. Page

2631. ATOMIC AND MOLECULAR STRUCTURE

III – 5c, 5m 2 – 2 –

The application of wave mechanics to some problems of atomic and molecular structure.

J. P. Valleau

DEPARTMENT OF POLITICAL ECONOMY

2720. ECONOMICS

II – All courses 2 – 2 –

An introduction to the study of Economics with special reference to the problems of the Canadian economy. Grades will be assigned on the basis of term work, essays and tests.

J. P. Warner

2730. POLITICAL SCIENCE

III – All courses (elective) 2 – 2 –

An introduction to political science, with special reference to the government of Canada. Those students who obtain a satisfactory term mark will not be required to write the final examination. Reference books: J. A. Corry and J. E. Hodgetts, *Democratic Government and Politics;* R. M. Dawson, *Government of Canada* (revised by Ward).

F. Peers, S. Taube

2734. ACCOUNTING

III – 4 2 – 2 –

Basic accounting principles and procedures, the preparation and interpretation of

financial statements, cost accounting, and the use of accounting as a means of control.

R. Paretz

DEPARTMENT OF GEOLOGY

2900. GEOLOGY FOR ENGINEERS

II – 1 2 – 1 3

An introductory course in geology with special reference to engineering problems.

W. W. Moorhouse

2901. X-RAY CRYSTALLOGRAPHY

III – 5m, 8 – 2 – 2

A laboratory course in X-ray diffraction methods for students in Metallurgy and Material Science.

E. W. Nuffield

2903. GEOLOGY

IV – 5g 2 2 2 2

Special topics in geology for students in Engineering Geophysics.

The staff in Geology

2920. PRINCIPLES OF GEOLOGY

II – 9 2 2 2 2

Basic concepts of physical and historical geology.

The staff in Geology

2921. MINERALOGY

II – 9 2 5 2 5

Introductory crystallography; the principles of mineralogy; classification and description of the common minerals; optical theory; the use of the polarizing microscope in the study of minerals; introduction to the study of rocks.

The staff in Geology

2930. PETROLOGY

III – 9 2 2 2 2

The principles of petrology; the classification, description and interpretation of the sedimentary, igneous and metamorphic rocks. Microscopic petrography. One laboratory report.

J. J. Fawcett

2931. STRATIGRAPHY AND SEDIMENTATION

III – 9 2 2 2 2

Principles of stratigraphy with emphasis on tectonic and environmental interpretation

of Precambrian and younger rocks. Problems of applied stratigraphy; petrographic interpretation.

F. W. Beales, W. W. Moorhouse

2932. STRUCTURAL GEOLOGY

III – 9 1 3 1 3

Development of structures in the sedimentary, igneous and metamorphic rocks of the earth's crust; laboratory study of methods employed in solving structural problems.

W. M. Schwerdtner

2933s. PETROLEUM GEOLOGY AND GROUND WATER

III – 9 2 3 2 3

Occurrence of oil and gas in sedimentary basins and the geological conditions that govern their entrapment; ground water and its relation to the geology of drainage basins; fluid flow through porous media.

J. B. Currie, W. D. Baines

2934. MINERAL IDENTIFICATION LABORATORY

III – 9 – 2 – 2

A continuation of the laboratory work in mineralogy of course 2921.

D. H. Gorman

2935. THEORY OF PHASE EQUILIBRIA

III – 9 2 – 2 –

Thermodynamics of phase equilibria, phase diagrams, mineral systems.

F. G. Smith

2937. GEOLOGICAL FIELD TRIPS

III – 9

Field trips to places of geological interest during the fall to complement the subjects studied in the III Year.

The staff in Geology

2940. MINERAL DEPOSITS

IV – 9 2 – 2 –

Theories of origin of mineral deposits; description of world's important mineral deposits.

W. H. Gross

2941. MINERAL DEPOSITS LABORATORY

IV – 9 – 3 – 3

A. J. Naldrett

2942. GEOLOGICAL DATA ANALYSIS

IV – 9 2 2 2 2

Applied mathematics, probability, statistics, computer programming.

F. G. Smith

2943. EXPLORATION GEOCHEMISTRY

IV – 9 1 3 1 3

Use of trace element analysis techniques as an aid to discovery of ore deposits.

G. M. Anderson

2944. MINERAL ECONOMICS

IV – 9 2 – 1 3

Economic principles pertaining to exploration, development and exploitation of mineral deposits.

W. H. Gross

2945. LABORATORY RESEARCH

IV – 9 – 3 – 3

A laboratory course stressing methods and experimental techniques applicable in geology.

G. M. Anderson, J. B. Currie, A. J. Naldrett

2946. GEOLOGY FIELD CAMP

IV – 9 14 days

A field course in the Tweed area of Ontario immediately following the Annual Examinations between the Third and Fourth Years.

The staff in Geology

2947. GEOLOGICAL FIELD TRIPS

IV – 9

Field trips to places of geological interest to complement the subjects studied in the IV Year.

The staff in Geology

DEPARTMENT OF COMPUTER SCIENCE

3310s. INTRODUCTION TO COMPUTER PROGRAMMING

I – All Courses – – 1 1

Introduction to algorithms and stored-programme computers; FORTRAN programming; applications to numerical and non-numerical programmes.

The Staff in Engineering and the Staff in Computer Science

3331s. ENGINEERING DATA PROCESSING

III – 8 – – 2 –

A course in programming and coding for the digital computer.

C. C. Gotlieb, R. W. P. Anderson

3332s. ENGINEERING DATA PROCESSING LABORATORY

III – 8 – – – 3

Practical work to accompany subject 3331.

C. C. Gotlieb, R. W. P. Anderson

3338s. ADVANCED PROGRAMMING I

III – 5cs 3 6 – –

Assembly language programming; the design and use of special programming languages such as list processors and algebraic manipulators.

3339s. ADVANCED PROGRAMMING II

III – 5cs – – 3 6

The construction of compilers; system programming, including time-sharing systems.

3340s. MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

IV – 5cs 2 – 2 –

Logic, recursive function theory, Turing machines and computability; theory of automata and formal languages; some aspects of graph theory.

SPECIAL LECTURERS

3440. ENGINEERING LAW

IV – 1, 3, 4, 7 1 – – –

A subject designed to co-ordinate the practice of engineering and law. Consideration is given to the characteristics, advantages and disadvantages of companies, partnerships and sole proprietorships, the promotion, organization and financing of companies, the duties of employees to employers, the duties and liabilities of engineers, statutes applicable to engineernig works, professional engineering associations, construction contracts, workmen's compensation, trade unions and industrial disputes. Textbook: *Engineering Law.*– Laidlaw, Young, and Dick.

W. O. Chris. Miller

SCHOOL OF ARCHITECTURE

3540. TOWN AND REGIONAL PLANNING

IV – 1B 1 3 1 3

Problems of world urbanization; nature of the megalopolis, its guidance and control;

urban functions and transportation; market analysis and research techniques; urban renewal. Laboratory work includes exercises in survey research and analysis, subdivision layout, and urban analysis.

D. Pinker, A. Waterhouse

VII General Regulations; Examinations

ATTENDANCE

1. Students proceeding to the degree are required to attend the courses of instruction and the examinations in all subjects prescribed. A student whose attendance at lectures or laboratories or whose work is deemed by the Council of the Faculty to be unsatisfactory, may have his registration cancelled at any time.

2. Students must conform to all lecture room and laboratory regulations. Reports, briefs, theses and drawings become the property of the Council to dispose of as it may see fit. Drawings, briefs and field notes will not be accepted unless they have been made at the time and place provided in the time table.

PENALITIES FOR UNSATISFACTORY WORK

(*a*) In the case of unsatisfactory work of a very serious nature, the Faculty Council may recommend to the Senate that a student be debarred from the University.

(*b*) A student who on two occasions has failed to obtain promotion to a higher year will be refused further registration in the Faculty. A failure in engineering or in a related course at another institution will be counted in the same way as a failure in this Faculty.

(*c*) A student whose work is unsatisfactory may be suspended from attendance by the Council of the Faculty for a period of time not exceeding two years and/or until the satisfaction of other conditions as it may see fit.

(*d*) A student who withdraws after February 15, or who does not withdraw but does not write the annual examinations, will be regarded for the purposes of these regulations as having failed his year.

APPEALS

A student wishing to appeal to the Senate against a decision of the Council of the Faculty should consult the Secretary of the Faculty or the office of the University Registrar about the preparation and submission of his petition to the Secretary of the Senate.

ANNUAL EXAMINATIONS

1. Annual examinations will be held in April except as provided in paragraph 2 below.

2. Annual examinations will be held at the beginning of the second term in subjects completed during the first term.

3. Promotion from one year to another is made on the basis of the student's weighted average in the annual examinations and laboratory and other term work. Subjects will be weighted according to the number of hours devoted to them, the hours assigned to laboratory subjects being given one half the weight of those in lecture subjects.

Pass standing and promotion to the next higher year will be granted to students who obtain a weighted average of 60% or greater in the work of the year. (For special requirements in the first year of Engineering Science, see page 35.)

4. The student's work is graded in the following manner:

On Overall Average		*On Individual Subjects*	
Marks	Standing	Marks	Grade
75 – 100%	I Class (Honours)	75 – 100%	1
66 – 74%	II Class	66 – 74%	2
60 – 65%	III Class	60 – 65%	3
Below 60%	Failure	50 – 59%	4
		Below 50%	5

5. Honour standing will be granted to students who obtain a weighted average of 75% or greater in the work of the year.

6. Honour graduate standing will be granted to students who obtain honours in the final year and in any one previous year.

7. The following regulations pertain to failure and repetition of a year:

(*a*) A student who fails may be permitted to repeat the work of a year, subject to the conditions set out in the following paragraphs of this section.

(*b*) Only one such repetition will be allowed in the student's entire undergraduate course. For the purpose of this regulation, a failure in engineering or in a related course at any other institution will be counted in the same way as a failure in this Faculty.

(*c*) A student repeating a year must take the full program of instruction.

(*d*) A student who fails in the Second, Third or Fourth Year may repeat the work of the year in the session immediately following, unless he has previously repeated a year or is for other reasons ineligible.

(*e*) A student who has been admitted to advanced standing and who fails in his first year of attendance must file an application for re-admission, following the procedure outlined in Section III, paragraph 6 of this calendar.

(*f*) A student who fails in the work of the First Year may apply for re-admission to the Faculty, subject to the conditions set out below. *Applications of students for re-admission to the First Year will be considered on their merits, in competition with all other applicants.*

(i) A student who fails in the work of the First Year but who has obtained an

average of 50% or over may apply for re-admission in the session immediately following.

(ii) A student who fails in the work of the First Year with an average lower than 50% may not apply for re-admission until one full session has elapsed.

(iii) A student who withdraws on or before February 15 may apply for re-admission in the session immediately following.

(iv) A student who withdraws after February 15, or who does not withdraw but does not write the final examinations is considered to have failed, and may not apply for re-admission until one full session has elapsed.

(v) Application for re-admission is made to the Office of Admissions on the regular admission application form, as outlined in Section III, paragraph 6, of this calendar.

9. A student should submit to Council immediately after its occurrence, evidence of any illness or mishap which occurs during the session; any petition for leniency on account of such incidents may be refused consideration if received after the third day following the last day of examinations.

10. A student will not be allowed to write any examinations if he has not paid all fees and dues for which he is liable at that time.

TERM EXAMINATIONS

Term examinations may be held in any subject and at any time at the discretion of the instructor, or by the order of the Council, and the results of such examination may be incorporated with those of the annual examinations in the same subjects.

EXTRA-CURRICULAR ACTIVITIES AND ACADEMIC CREDIT

It is in general desirable for students to engage to a reasonable extent in extra-curricular activities in order that they may not become too narrowly professional in interests and outlook, but it will be obvious that no academic credit or consideration can be given for such activities. Some offices in student organizations require quite large amounts of time for the proper performance of the duties connected with them, and it is therefore strongly recommended that students, particularly those whose academic records are not high, consult a senior member of staff before allowing themselves to be nominated for such offices.

TRANSFER OF COURSE

An undergraduate student who wishes to transfer from one course to another within the Faculty must petition to the Faculty Council and obtain its approval. Petitions for transfer of course must be submitted not later than 15 August.

VIII Medals, Prizes, Scholarships and Bursaries

Through the generosity of friends of the University, governments and commercial organizations, encouragement has been given to undergraduate work in the various branches of engineering study by the establishment of the scholarships, prizes, bursaries and medals listed in the following pages.

ADMISSION SCHOLARSHIPS AND BURSARIES

Ontario Students:

Scholarships and bursaries available to students entering the First Year are listed on pages 126 and 127. For full details concerning these awards, applicants should consult the Calendar of Admission Awards, which is available at Secondary Schools or from the Office of Student Awards, Simcoe Hall, University of Toronto. Applications, which must be made through the Principal of the Secondary School, close on May 1 annually.

Non-Ontario Students:

All non-Ontario students should apply to the Office of Student Awards, Simcoe Hall, University of Toronto. A limited number of scholarships is reserved for students living outside the Province of Ontario, but as competition is keen such students must not count on receiving assistance but are advised rather to ensure that they have sufficient funds from their own government or from private sources to cover all probable expenses.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed on pages 127 to 130. Where it is necessary to make application for an award it is so stated in the description and particulars are given as to how the application should be made. In all other cases the award is made on the recommendation of the Faculty Council and no application is necessary.

GENERAL TERMS AND CONDITIONS

In order to be eligible for a medal, prize, scholarship, bursary, fellowship or other award granted solely upon standing obtained at an annual or special examination or

upon an essay, or term work, or other academic rating, a candidate must obtain honours at such annual or special examination or upon such essay, term work, or other academic rating unless the terms of the award specify that standing lower than honours may be accepted.

When an award or medal is granted upon standing obtained on part of the work of any academic year the candidate must obtain standing but need not obtain honours in the work of the academic year as a whole, provided he obtains honours in the part concerned, unless the terms of the award or medal specify otherwise.

No medal, prize, scholarship, bursary, fellowship or other award will be granted to a candidate who is conditioned in any subject at an annual examination unless the terms of the award or medal specify otherwise.

A candidate will not be permitted to receive more than one award in a session unless the statute establishing each of the awards concerned or the Calendar specifies otherwise. Only one of those marked by an asterisk may be held in any one year. A candidate who would, but for this provision, have received more than one award may have his name so published in the class lists.

A candidate who has spent two sessions in any year of an undergraduate course is not eligible to compete for any award at the annual examinations of that year.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes other than awards for graduate study and research, will be paid in one instalment as soon as possible after the granting of the awards.

All other awards will be paid (i) if of the value of $100 or less, in one instalment on November 20 and (ii) if of the value of more than $100 in two equal instalments, the first on November 20 and the second on January 20, in the session following the granting of the awards. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

The Senate may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance upon lectures and laboratory classes for one year. Further postponement may be permitted on application.

NOTE – As the value of an endowed scholarship or prize is dependent on the actual income of the fund, it is possible that the value of certain scholarships and prizes at the time of payment may be greater or less than the amount stated in the calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

AVAILABLE TO STUDENTS ENTERING THE FIRST YEAR

(† *indicates that application is required*)

Alumni Association War Memorial Scholarships	†	$ 500	page 155
Alcan Scholarship	†	$ 500	131

J. P. Bickell Foundation Scholarships	†	$ 500	134
J. W. Billes Admission Scholarships	†		135
Children of War Dead Education Assistance	†		136
Dominion Magnesium Limited Bursary	†	$ 400	137
Engineering Alumni Admission Scholarships (7)	†	$1000	138
Grabill Admission Scholarship	†	$ 500	140
General Foods Scholarships	†	$ 500	140
Hagarty Memorial Scholarship	†	$ 60	140
The Murray Calder Hendry Scholarship	†	$ 500	142
International Nickel Scholarship	†	$ 300 + Fees	142
The Leonard Foundation Scholarships	†		143
J. Edgar McAllister Foundation	†		144
O.H.A. War Memorial Scholarship	†	$ 200	148
Ontario Chapter American Society for Metals Bursaries (2)	†	$ 400	132
Ontario Student Awards Programme	†		137
A.P.E.O. Admission Scholarship	†	$ 500	149
Regular Officer Training Plan	†		151
Helen E. Rogers Admission Scholarships	†		151
Simpson-Sears Limited (Northern Ontario) Scholarship	†	$ 100	153
Walter Sterling Admission Scholarships	†		154
U.T.S. Engineering Scholarship	†	$ 250	156
Wallberg Admission Scholarships (2)	†	$ 500	156

AVAILABLE TO STUDENTS COMPLETING THE FIRST YEAR

(† *indicates that application is required*)

Atkinson Incourse Bursaries	†		132
Baptie Scholarship		$ 175	133
Canadian Bechtel Limited Bursaries	†		133
J. P. Bickell Foundation Scholarships			134
T. H. Bickle Prize		$ 30	134
Crocker Foundation Bursaries	†		137
John M. Empey Scholarship		$ 170	138
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		142
Inco Scholarship	†		142
Johnson's Wax Scholarship		$ 800	143
Kimberly-Clark Scholarship		$ 500	143
John Wolfe McColl Awards	†		144
Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science		$ 110	145
MacLennan – MacLeod Memorial Prize		$ 25	146
*Marsland Engineering Ltd. Scholarship		$ 250	147

Northern Electric Undergraduate Scholarship		$ 500	147
Ontario Student Awards Programme	†		137
Orenda Limited Scholarship		$ 500	141
Paulin Memorial Scholarship		$ 475	148
Procter and Gamble Bursary	†		149
*Professional Engineers Scholarship		$ 250	149
Ransom Scholarship in Chemical Engineering		$ 250	150
Frederick W. Schumacher Scholarship	†		152
S. Ubukata Fund	†		155
University of Toronto General Bursaries	†		155
*Wallberg Undergraduate Scholarships (2)		$ 500	156

AVAILABLE TO STUDENTS COMPLETING THE SECOND YEAR

(† *indicates that application is required*)

Harvey Aggett Memorial Scholarship		$ 75	131
Ardagh Scholarship		$ 350	132
Association of Ontario Land Surveyors Scholarship	†	$ 500	132
Automotive Transport Association Bursary	†		132
Babb Bursary Fund	†		133
Canadian Bechtel Limited Bursaries	†	$1200	133
J. P. Bickell Foundation Bursaries	†		134
J. P. Bickell Foundation Scholarships			134
T. H. Bickle Prize		$ 30	134
Carveth Metallurgical Ltd. Bursary	†	$ 500	135
5T6 Civils Scholarship	†	$ 200	136
Crocker Foundation Bursaries	†		137
Cyanamid of Canada Scholarship		$ 900	137
John M. Empey Scholarship		$ 170	138
J. A. Findlay Scholarship		$ 80	139
Hugh Gall Award	†	$ 140	140
Hydro-Electric Power Commission of Ontario Bursary	†	$ 500	142
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		142
Kimberley – Clark Scholarship		$ 500	143
Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships			145
Charles Gordon Manning Prize			146
*Marsland Engineering Ltd. Scholarship		$ 250	147
James L. Morris Memorial Prize		$ 125	147
Northern Electric Undergraduate Scholarship		$ 500	147
Ontario Student Awards Programme	†		137
Orenda Limited Scholarship		$ 500	141
*Spruce Falls Power and Paper Company Scholarships		$ 400	154
William Storrie Memorial Scholarship		$ 100	154

*Professional Engineers Scholarship		$ 250	149
*Rhodes Scholarship	†	£1000	150
Frederick W. Schumacher Scholarship	†		152
Edith Tyrrell Memorial Bursary	†	$ 600	154
University of Toronto General Bursaries	†		155
*Wallberg Undergraduate Scholarships		$ 500	156
William R. Worthington Memorial Scholarship		$ 400	157

AVAILABLE TO STUDENTS COMPLETING THE THIRD YEAR

(† *indicates that application is required*)

American Institute of Industrial Engineers Scholarship		$ 150	131
Babb Bursary Fund	†		133
F. W. Baldwin Prize		$ 75	133
Canadian Bechtel Limited Bursaries	†		133
J. P. Bickell Foundation Bursaries	†		134
T. H. Bickle Prize		$ 30	134
*Boiler Inspection and Insurance Company Scholarship		$ 300	135
*Chevron Standard Limited Scholarship		$ 500	135
Chemical Institute of Canada Prize		$ 25	136
Crocker Foundation Bursaries	†		137
Dow Chemical of Canada Limited Award		$ 500	138
John M. Empey Scholarship		$ 170	138
E.I.C. Prize		$ 50	139
Engineering Society Semi-Centennial Award		$ 75	139
J. A. Findlay Scholarship		$ 80	139
James Franceschini Foundation Scholarship		$ 250	139
Chester B. Hamilton Scholarship		$ 500	141
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		142
Cominco Scholarships	†	$ 800	136
*Jenkins Scholarship in Engineering		$ 200	143
Loan Funds	†		157
J. A. D. McCurdy Prize		$ 75	144
Alexander MacLean Scholarship		$ 250	146
*Marsland Engineering Ltd. Scholarship		$ 250	147
Northern Electric Undergraduate Scholarship		$ 500	147
Ontario Student Awards Programme	†		137
Orenda Limited Scholarship		$ 500	141
*Professional Engineers Scholarship		$ 250	149
RCE Memorial Scholarship	†	$ 125	151
Don Salt Memorial Scholarships	†	$ 500	152
Murray F. Southcote Scholarship		$ 100	153
Frederick W. Schumacher Scholarship	†		152
William Storrie Memorial Scholarship		$ 100	154

*Spruce Falls Power and Paper Company Scholarships		$ 400	154
Edith Tyrrell Memorial Bursary	†	$ 600	154
University of Toronto General Bursaries	†		155
*Wallberg Undergraduate Scholarships		$ 500	156

AVAILABLE TO STUDENTS COMPLETING THE FOURTH YEAR

(† *indicates that application is required*)

Henry G. Acres Medal			130
American Society of Lubrication Engineers Prize		$ 75	131
J. P. Bickell Foundation Bursaries	†		134
Babb Bursary Fund			133
Crocker Foundation Bursaries	†		137
Electrical Manufacturing Co. Limited Prize		$ 25	138
Hamilton Watch Award			141
Loan Funds	†		157
Massey-Ferguson Ltd. Scholarships (2)	†	$ 500	147
Ontario Municipal Electric Association Bursary	†	$ 300	148
Ontario Student Awards Programme	†		137
Professional Engineers Gold Medal			149
J. E. Reid Memorial Prize		$ 50	150
William Storrie Memorial Scholarship		$ 200	154
Wallace Award, Society of Automotive Engineers Prize		$ 100	153
Society of Chemical Industry Merit Award			153
"Second Mile Engineer" Award		$ 200	152
University of Toronto General Bursaries	†		155
W. S. Wilson Medals			156

HENRY G. ACRES MEDAL

The Henry G. Acres Medal is the gift of Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario in the period 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. Entering private practice in 1924, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which was vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

This medal is awarded annually to the student in the Fourth Year who is registered in the course in Civil, Mechanical, or Electrical Engineering, and who obtains the

highest aggregate percentage at the annual examinations of the Third and Fourth Years, provided always that the student obtains honour standing in the examinations of the Fourth Year. Receipt of the medal does not preclude a student from being granted such other award as may in the opinion of the Council be appropriate.

HARVEY AGGETT MEMORIAL SCHOLARSHIP

This scholarship was donated by the late Mr. J. T. Aggett, of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual scholarship of the value of the annual income from the fund is to be awarded to a student of the Second Year in this Faculty who, obtaining honours and being one of the first three in his year by his standing at the annual examinations, has been adjudged highest of the three in general student activities and service in the University during his period of attendance. When regulations do not permit the winner to hold this scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a scholarship of higher value.

ALCAN SCHOLARSHIP

The Aluminum Company of Canada, Limited, has made available an admission scholarship of a value of $500 to a student entering the First Year of an Honours Course in the Faculty of Arts and Science, the Faculty of Applied Science and Engineering or in the Faculty of Law. The recipient must attain an academic standing satisfactory to the Committee of Award and demonstrate financial need. It is tenable in the later years provided First Class standing is maintained.

Application should be made to the Registrar of the University by May 1 on the regular Admission Scholarship Application form.

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS SCHOLARSHIP

The Southern Ontario Chapter, American Institute of Industrial Engineers offers a scholarship of $150 to a student entering the Fourth Year of the Industrial Engineering course who has consistently maintained a high academic standing, but not necessarily honour standing, during the previous three years.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS PRIZE

The Toronto section of the American Society of Lubrication Engineers offers an annual prize of $75 to a student in the Fourth Year in Mechanical Engineering whose Thesis dealing with Lubrication is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory. The Prize is accompanied by a donation of $25 to the Department to purchase books on Lubrication.

ONTARIO CHAPTER, AMERICAN SOCIETY FOR METALS BURSARY

The Ontario Chapter, American Society for Metals provides two bursaries of a value of $400 each for students entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made for the Session 1958–59.

ARDAGH SCHOLARSHIP

The Ardagh Scholarship, of the annual value of the income from $7,500, has been provided in memory of his parents by Professor E. G. R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry in the Faculty. It is awarded to the student who attains the highest standing in all Honours at the annual examination of the Second Year in the Course in Chemical Engineering. The first award was made on the results of the annual examination of 1946.

ASSOCIATION OF ONTARIO LAND SURVEYORS SCHOLARSHIP

The Association has established a scholarship of $500 to be awarded to a student registered in the Surveying Option in the Third Year of the course in Civil Engineering at the University of Toronto or an equivalent course at any other University. This award will be granted by the Association at its annual meeting in February with due consideration being given to the following points:

(a) Through his activities, the student must show leadership ability and give promise of becoming a worthwhile influence in the affairs of the profession.

(b) While attention is given to scholastic ability, as evidenced by his academic standing, other factors also will be considered.

(c) Special consideration is to be given to financial need

Students must apply to the Secretary of the Association of Ontario Land Surveyors, 8 King Street East, Toronto 1, Ontario, by letter prior to December 31 of the calendar year preceding that in which the award is to be granted.

ATKINSON IN-COURSE BURSARIES

Atkinson In-Course Bursaries, gift of the Atkinson Charitable Foundation, are awarded annually to students in the second or higher years of their courses. Applicants must have at least Second Class honours in the final examinations of the preceding year, demonstrate financial need and be a resident of the Province of Ontario.

Applications must be submitted to the Registrar of the University on or before December 1.

ATA TRUCKING INDUSTRY EDUCATIONAL FOUNDATION BURSARIES

The Automotive Transport Association of Ontario has established a bursary fund for students in the second or higher years of any undergraduate degree course who find

themselves in serious financial need due to sudden, unexpected personal or family difficulties. Applications may be submitted to the University Registrar at any time during the session and the number and value of the bursaries will vary at the discretion of the Committee of Award.

THE BABB BURSARY FUND

Bursaries from this fund are available to students in any year of the Aeronautics Option in Engineering Science. Application is made through the Secretary of the Faculty.

THE F. W. BALDWIN PRIZE

The F. W. Baldwin Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44), in memory of Frederick Walker "Casey" Baldwin, a graduate of the School of Practical Science, who made a significant contribution in the field of Aeronautics in Canada; and who flew, on March 12, 1908, near Hammondsport, N.Y., the "Redwing," the first biplane built by the Aerial Experiment Association.

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in the annual examinations of Third Year in "structural subjects."

The first award was made on the results of the examinations of the Session 1953–54.

BAPTIE SCHOLARSHIP

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie, of Ottawa, and the Board of Governors has directed that a scholarship of one half the annual income shall be be awarded annually to an engineering student on the record of the first Year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to $75.

The conditions of the award are as follows: That the scholarship be awarded to the student who, in the annual examinations of the First Year, enrolled in any one of the courses of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, or Metallurgy and Materials Science, obtains the highest aggregate percentage of marks in those subjects which are common to the First Year curricula of those courses. The first award was made on the results of the annual examinations of the Session 1925–26.

CANADIAN BECHTEL LIMITED BURSARIES

Canadian Bechtel Limited has established Bursaries in the Faculty of Applied Science and Engineering of an annual value of $1,200 to provide not more than four awards, each of a minimum value of $200 and a maximum value of $600. Two awards will be made to First Year students and one or two awards to students registered in any year

of the Faculty. Applicants must demonstrate financial need and have academic standing satisfactory to the Faculty Council.

Application must be made to the Secretary of the Faculty on or before October 1.

J. P. BICKELL FOUNDATION SCHOLARSHIPS

The Trustees of the J. P. Bickell Foundation have established scholarships, the number to be determined annually, in the Faculty of Applied Science and Engineering of a possible value of $1,500 payable $500 in the First Year and provided honours are obtained at the Annual Examinations, $500 in the Second and Third Years.

An applicant must obtain an average of at least 75% at the Ontario Grade XIII examinations immediately preceding his admission to the university and must undertake to enrol in Chemical Engineering, Metallurgy and Materials Science or Geological Engineering. Failing suitable candidates in the courses mentioned students registered in the Second Year Honor course in Geological Sciences, or Physics and Geology in the Faculty of Arts and Science who are academically qualified are eligible. These awards are of the same value and are tenable in the Second, Third and Fourth Years of the course, subject to maintenance of the required academic standing. If any scholarships are not awarded to those mentioned above, students registered in the Third Year of the Engineering Science course in the Faculty of Applied Science and Engineering and taking the Physical Metallurgy or the Geophysics option who are academically qualified are eligible. In this case the scholarship will have a value of $1,000, payable $500 in each of the Third and Fourth years, provided the required academic standing is maintained.

Applications from those entering First Year must be submitted to the Registrar of the University not later than May 1 on the regular admission scholarship application form. In other cases, applications are not required.

J. P. BICKELL FOUNDATION BURSARIES

The Trustees of the J. P. Bickell Foundation have established the J. P. Bickell Foundation Bursaries in the Faculty of Arts and the Faculty of Applied Science and Engineering. An applicant must be enrolled in Honour Science or in Mathematics, Physics and Chemistry in the Faculty of Arts, in which case he must undertake to study mining or geology in his higher years; or be enrolled in a higher year of an honour course in the geological or geophysical field in the Faculty of Arts; or be enrolled in Chemical Engineering, Mining Engineering, Metallurgy and Materials Science, or Geological Engineering in any year of the Faculty of Applied Science and Engineering. He must demonstrate financial need and have satisfactory academic standing.

Application must be made to the Registrar of the University on or before December 1.

THE T. H. BICKLE PRIZE

The T. H. Bickle Prize is the gift of Mr. and Mrs. E. W. Bickle in memory of their son, T. H. Bickle, an undergraduate of Trinity College and a member of the Senior Inter-

collegiate Swimming Team at the time of his death in 1937. The income from the endowment fund will be used to purchase a suitable prize to be awarded annually to a member of the Senior Intercollegiate Swimming Team of this University in any year, faculty or school. The Committee of Award shall consist of the Dean of the Faculty of Arts, the University Registrar, the Director of Athletics, and the Honorary Coach of Swimming. In awarding the Prize the Committee shall consider the character, scholarship, and general interests of the members of the team.

J. W. BILLES ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of J. W. Billes, open to students entering any degree course in the University. The value in each year is a minimum of $200 and a maximum of $1,500 dependent upon the financial need of the recipient. Applicants must satisfy the normal admission scholarship standards in their Grade XIII examinations to be eligible for an award and maintain first class honour standing to enjoy the scholarship in higher years. The number of scholarships awarded in any one year may be varied dependent upon the available funds.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

BOILER INSPECTION AND INSURANCE COMPANY SCHOLARSHIP

The Boiler Inspection and Insurance Company of Canada offers a scholarship in the Course in Mechanical Engineering of the value of $300 to the student who obtains highest honour standing in the regular examinations of the Third Year.

The successful candidate will be expected to proceed to his Fourth Year during the session next following the date of the award.

The amount of the award will be credited by the Chief Accountant to the fees of the Fourth Year of the successful candidate.

CHEVRON STANDARD LIMITED SCHOLARSHIP

Chevron Standard Limited has presented a scholarship of $500 to a student who achieves outstanding results in the annual examinations of the Third Year in the Geophysics Option in Engineering Science or in Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and Science.

The awards alternate annually between the Faculties of Applied Science and Engineering and Arts and Science and the First Award was made in the session 1960–61 in the Faculty of Applied Science and Engineering.

CARVETH METALLURGICAL LTD. BURSARY

Carveth Metallurgical Ltd. provides one or more bursaries to a total value of $500 for students entering the Third Year of Metallurgy and Materials Science. The award is

made primarily on the basis of Second Year standing, but the need for financial assistance will also be taken into consideration.

The Bursary is available every third year, beginning in the Session 1961–62, and is to be awarded on the recommendation of the Department of Metallurgy and Materials Science. Applications should be made by letter to the Secretary of the Faculty of Applied Science not later than September 1 of the year in which the award is tenable.

CHEMICAL INSTITUTE OF CANADA PRIZE

The Chemical Institute of Canada offers a prize of the annual value of $25 in books to the student registered in the course in Chemical Engineering who, having obtained honours, receives the highest standing in the written and laboratory work of the Third Year.

The first award was made on the results of the final examinations of 1947.

CHILDREN OF WAR DEAD (EDUCATION ASSISTANCE) ACT

Children of War Dead (Education Assistance) Act provides fees and monthly allowances for children of veterans whose death was attributable to military service. Enquiries should be directed to the nearest District Office of the Department of Veterans Affairs.

5T6 CIVILS SCHOLARSHIP

The 5T6 Civils, consisting of the graduating members of the 1956 Civil Engineering Class of the University of Toronto, have established an annual scholarship of the value of $200.00 open to students in the Second Year of the course in Civil Engineering. The selection of the recipient is based on evidence of the qualities of scholarship, leadership and character. The award is not tenable with any other scholarship of greater value.

The award is presented at the annual reunion of the Class of 5T6 Civils. The first award was made in 1964.

Students who wish to be considered for this scholarship should write to the Class of 5T6 Civil Engineering, c/o Alumni House, University of Toronto, not later than December 31, giving full particulars of their academic record, and their extra-curricular activities both within and outside the University.

COMINCO SCHOLARSHIPS

Two scholarships, of an annual value of $800 each, are provided by Cominco Limited and are offered to students in the Third Year of the courses in Chemical Engineering, Geological Engineering, Mechanical Engineering and Metallurgy and Materials Science in the Faculty of Applied Science and Engineering and to students in the Third Year of the courses in Chemistry and Geology in the Faculty of Arts and Science, the awards being made on the basis of the examination results of the Second Year. The scholarships may be renewed in the Fourth Year if satisfactory standing is maintained.

Application must be made to the Secretary of the Faculty on the regular in-course awards form not later than October 15.

CROCKER FOUNDATION BURSARIES

The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

CYANAMID OF CANADA SCHOLARSHIP

As a part of their programme to encourage technical development in Canada, Cyanamid of Canada Limited offers a scholarship of the value of $900 to a student entering the Third Year in Chemical Engineering or Industrial Engineering. The award is made to a student who has demonstrated high academic ability and outstanding scholarship in the work of the Second Year.

The first award at the University of Toronto was made in 1964.

DOMINION MAGNESIUM LIMITED BURSARY

Dominion Magnesium Limited provides a bursary of $400 for a student entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made in the Session 1958-59.

PROVINCE OF ONTARIO STUDENT AWARDS PROGRAMME

Awards under this programme will be made available to all Ontario students provided:
(i) they are in full-time attendance at a Canadian University (or other eligible institution).
(ii) they can demonstrate need for financial assistance.
(iii) they are either Canadian citizens or landed immigrants, have resided in Canada for at least twelve months and intend to reside permanently in Canada.

Each applicant's need will be assessed by the Department of University Affairs and the first $150 of the total established need will be paid in loan form. Of the balance 60% will be made available as a loan and 40% will be in the form of a bursary.

Aplication forms and further information are available at high schools for students entering the first year; students in attendance in the Faculty may obtain application forms from the Secretary.

DOW CHEMICAL OF CANADA LIMITED AWARD

Dow Chemical of Canada Limited have provided funds for an annual award of $500 to a student in Chemical Engineering in the Faculty of Applied Science and Engineering, and grant-in-aid of $250 to be used in the winner's department to help defray the cost of equipment, supplies and administration.

The winner must:

(*a*) be registered in the Third Year in Chemical Engineering (the award will be made in the second term of the Third Year and will be paid to the winner during his Fourth Year);

(*b*) be in the upper half of the class;

(*c*) have demonstrated leadership in extra-curricular activities.

The award is not tenable with other awards in the gift of the Senate. Application is not required.

THE ELECTRICAL MANUFACTURING COMPANY LIMITED PRIZE

The Electrical Manufacturing Company Limited has established an annual Prize of $25 in the Faculty of Applied Science and Engineering.

The winner must:

(*a*) be registered in the Fourth Year in Electrical Engineering;

(*b*) obtain the highest aggregate percentage of marks at the final examinations in the subjects of the Fourth Year related to electrical distribution equipment, the subject to be determined by the Head of the Department of Electrical Engineering.

This Prize is tenable with other awards in the gift of the Senate.

THE JOHN M. EMPEY SCHOLARSHIPS

The John M. Empey Scholarship Fund was established under a bequest of $10,000 in the Will of the late John Morgan Empey, B.A.SC., 1903. Three scholarships of equal value are provided from the income from the Fund. One of these scholarships is awarded in each of the First, Second, and Third Years on the results of the annual examinations, to a student who, taking honours, obtains the highest average percentage of marks in the written and laboratory subjects of his Year. The scholarships are open to any students registered in the Faculty. In case the winner of any one of these scholarships does not attend this Faculty during the session next following the award, the right to the scholarship shall be forfeited and the award shall be made to another eligible student. The scholarships were awarded for the first time in 1944.

ENGINEERING ALUMNI ADMISSION SCHOLARSHIP

Seven scholarships, each of the value of $1000, are provided annually by the University of Toronto Engineering Alumni Association for students entering the first year of any course in the Faculty of Applied Science and Engineering. The awards are made on the basis of standing in the Ontario Grade XIII examinations.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

ENGINEERING INSTITUTE OF CANADA PRIZE

The Engineering Institute of Canada, having in view that one of its objects is to facilitate the acquirement and interchange of professional knowledge among its members, offers an annual prize of Fifty Dollars in this University, commencing 1931, to the student who, in his Third Year in any one of the six courses of Engineering, has proved himself most deserving as disclosed by the examination results of the year, in combination with his activities in the Engineering Society or with a local branch of another recognized engineering organization.

ENGINEERING SOCIETY SEMI-CENTENNIAL AWARD

The Engineering Society Semi-Centennial Award, to the value of $75 was established in 1931 to commemorate the semi-centennial of the founding of the "School." The award is made to a student entering the final year.

The selection is based upon the following qualifications, which bear equal weight in the selection of the winner: (*a*) General "School" activities. (*b*) Contributions to the Engineering Society Executive Committee. (*c*) Personality, and social and athletic activities. (*d*) Academic standing.

J. A. FINDLAY SCHOLARSHIPS

These scholarships were established through a legacy bequeathed by the late Miss Janet Findlay to the Department of Mechanical Engineering. Two scholarships are available, each of a value of one half of the income of the fund, to students in this Course, one for a student in the Third Year, the other for a student in the Fourth Year, but only if the student continues his course in Mechanical Engineering. The selection will be made, on recommendation of the Head of the Department of Mechanical Engineering, from amongst the four students having the highest average percentage of marks at the annual examinations in the Second and Third Years respectively, but in making the award the student's general character, fitness for his profession, and financial circumstances will be given consideration. In case a student who has been awarded one of the scholarships changes his course or does not attend this University during the next following session, he shall forfeit his right to the scholarship and the award shall be made to another eligible student.

THE JAMES FRANCESCHINI FOUNDATION SCHOLARSHIP

This scholarship, of a value of $250, is awarded to the student in Civil Engineering who achieves the highest standing, with honours, at the annual examinations of the Third Year among those who do not hold an award of a value of $100 or more based on the results of these examinations.

HUGH GALL AWARD

The Hugh Gall Award, of the annual value of One Hundred and Forty Dollars, the gift of the Graduate Class of 1910, "to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career," was established in 1946 for a five year period and, through the generosity of Mrs. Hugh Gall extended for a further three year period. It is awarded to a student, who, having completed his First Year with a general average of at least 66% without conditions, has entered the Second Year, and is in special need of financial assistance in order to enable him to continue his course. It is desirable, but not necessary, that the recipient shall not already have been given any other scholastic award or scholarship applicable to the second year and he shall have shown indications of his firm intention and ability to follow successfully the profession of engineering.

Any second year student in the Faculty of Applied Science and Engineering is eligible to apply for this Bursary. Applications should be made to the Secretary of the Faculty not later than one month after the opening of the session.

GENERAL FOODS SCHOLARSHIP

This scholarship is awarded for general proficiency in the final secondary school year to a student entering the Faculty of Arts and Science, Applied Science and Engineering or Food Science, and is open for competition by any student resident in Canada. The value is $500 for each of four years, providing first class standing is maintained.

Ontario residents apply on the regular admission scholarship application form.

Students resident outside Ontario may obtain application forms from the Awards Department, Office of the Registrar, University of Toronto.

THE GRABILL ADMISSION SCHOLARSHIP

The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $500. It is awarded to the candidate who has standing amongst those with the highest average percentages in the subjects of Ontario Grade XIII required for admission to the Faculty of Applied Science and Engineering. The candidate must write the Grade XIII examinations at one sitting in the June preceding entry to the University after not more than one year's instruction in Grade XIII and must register in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University on the regular Admission Scholarship form by May 1.

THE REGINALD AND GALER HAGARTY SCHOLARSHIP

The Reginald and Galer Hagarty Scholarship, in memory of the dearly beloved sons of Lieutenant-Colonel E. W. Hagarty, B.A. 1883, M.A. 1908, and Charlotte Ellen Hagarty, his wife. Reginald Edward Walter Hagarty, B.A.SC. (Honours) 1908, a

graduate of the University in the Faculty of Applied Science and Engineering and at the time of his death on April 29, 1925, a Consulting Structural Engineer. Lieutenant Daniel Galer Hagarty, Princess Patricia's Canadian Light Infantry, a member of the class of 1916 in Applied Science, enlisted for the Great War at the end of his third year in June, 1915, killed in action in Sanctuary Wood, June 2, 1916. The scholarship is given in recognition of the fact that their father was an honour graduate in Classics of the University of Toronto. It is of the value of the annual interest on the capital sum of $2,000 and is to be awarded to a student who has been enrolled for his Grade XIII Year at Harbord Collegiate Institute and having obtained at least the required standing in each of the Grade XIII subjects necessary for admission to the Faculty, obtains the highest standing in English, a language other than English, and Mathematics, among the students who apply for the award from the Collegiate. He will be required to: (*a*) register in the Faculty of Applied Science and Engineering, (*b*) sign a declaration to the effect that he is willing to take up arms in the defence of Canada and the British Commonwealth should necessity arise as declared by the Parliament of Canada. The Scholarship was offered for award for the first time in 1945. Application should be made to the Registrar of the University on the regular admission scholarship application form not later than May 1.

CHESTER B. HAMILTON SCHOLARSHIP

Members of the family of the late Chester B. Hamilton, a graduate of the Faculty in 1906, have presented a Scholarship in his memory of the annual value of $500. It is held by a Fourth Year student in Mechanical Engineering who has achieved outstanding academic standing at the Annual Examinations of the Third Year.

The first award was made on the results of the examinations for the Session 1958-59.

HAMILTON WATCH AWARD

Hamilton Watch Company, Lancaster, Pa. presents a wrist watch, suitably engraved, to the Fourth Year student in the Faculty of Applied Science and Engineering who at the annual examinations attains Honour standing and who has achieved high aggregate marks during his four years in the social-humanistic subjects common to all courses.

ORENDA LIMITED SCHOLARSHIPS

Orenda Limited has donated three scholarships each of a value of $500, awarded annually to students completing the First, Second and Third Years respectively in courses other than Geological Engineering. These scholarships are awarded to students with high academic standing and in cases of close competition, preference will be given to the student who indicates that he possesses initiative and leadership qualities and that he will be a credit to his profession after graduation.

This award may be held with other awards provided that the monetary value of the other awards does not exceed $100. The first award was made in the Session 1955-56.

THE MURRAY CALDER HENDRY SCHOLARSHIP

This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of the income from a capital sum of $10,000 and the recipient must:
(a) have attained an average of at least 75% on the grade XIII examination papers, written at one sitting, required for admission to the Faculty.
(b) be entering the First Year of any course in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University by May 1 on the regular University Admission Scholarship Application form.
The first award was made in the Session 1962-63.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO BURSARY

The Hydro-Electric Power Commission of Ontario has provided a bursary of the value of $500, which may be awarded to a student entering the second year of the courses in Mathematics and Physics or Commerce and Finance in the Faculty of Arts and Science, or any course in the Faculty of Applied Science and Engineering. Application should be made on the regular in-course bursary form not later than December 1.

IBM – THOMAS J. WATSON MEMORIAL BURSARY FUND

International Business Machines Company Limited has made available one or more bursaries of a total annual value of $1,000 to students registered in any year of a full time course in the university who have standing satisfactory to the committee of Award and demonstrate financial need.

Application should be made to the Registrar of the University by October 31.

INTERNATIONAL NICKEL SCHOLARSHIPS

The International Nickel Company of Canada, Limited, annually provides one scholarship to students entering the University of Toronto for studies in Engineering, Geology, Geophysics, Mathematics, Physics of Chemistry with preference being given to Metallurgical Engineering. Awards are renewable for three additional academic years provided satisfactory standing is maintained.

Valued at $1,200 annually, each scholarship provides for tuition and fees, a $300 living allowance, and a grant of up to $500 to the University as a cost-of-education supplement.

To be eligible for consideration the applicant must obtain an average of 75% or over in the Ontario Grade XIII subjects required for admission to his course and demonstrate financial need.

Application must be made to the Registrar of the University by May 1 on the regular scholarship application form.

JENKINS SCHOLARSHIP

The Jenkins Scholarship, presented by Jenkins Bros., Limited, Montreal, first awarded in 1925, has been donated to continue indefinitely.

This Annual Scholarship, of the value of $200, is awarded to the student of the Third Year registered in any course of the Faculty who has the highest aggregate of percentages for the First, Second and Third Years.

JOHNSON'S WAX SCHOLARSHIP

S. C. Johnson and Son Limited, Brantford, Ontario, have established a Scholarship of an annual value of $800 in each of the Second, Third and Fourth Years or a total possible value of $2,400.

The recipient must:

(*a*) be registered in Chemical Engineering in the years in which the Scholarship is awarded and held;

(*b*) in the opinion of the Council be the most promising and deserving member of the class, obtaining Honours in the final examinations of the First Year;

(*c*) in his Second and Third Years, maintain academic standing satisfactory to the Council, not necessarily Honours, for the continued enjoyment of the Scholarship.

In its discretion the Council may recommend the award of any portion of the Scholarship, lost by the original recipient by failure to maintain satisfactory academic standing, to another student of the year(s) in which the Scholarship would otherwise have been enjoyed.

The first award was made on the results of the annual examinations written in April 1954. It is not tenable with any other Scholarship.

KIMBERLY-CLARK CORPORATION OF CANADA LIMITED SCHOLARSHIPS

Kimberly-Clark Corporation of Canada Limited has presented two scholarships of a value of $500 each and each scholarship is accompanied by a grant of $100 to the general funds of the University. One scholarship is awarded to an outstanding student of the First Year and one to an outstanding student of the Second Year as indicated by the examination results of their respective years. Students in all courses of the First and Second Years are eligible.

The first awards were made on the results of the annual examinations for 1957-58.

THE LEONARD FOUNDATION SCHOLARSHIPS

Leonard Foundation Scholarships are awarded each year to selected students in Universities and Colleges across Canada, including the University of Toronto. The Trust Deed

states: "Preference in the selection of students for scholarships shall be given to the sons and daughters respectively of the following: (*a*) clergymen, (*b*) school teachers, (*c*) officers, non-commissioned officers and men, whether active or retired, who have served in Her Majesty's military, naval or air forces, (*d*) graduates of the Royal Military College of Canada, (*e*) members of the Engineering Institute of Canada, (*f*) members of the Mining and Metallurgical Institute of Canada."

All applicants must be nominated by a member of the General Committee. The latest date for the receiving of applications is March 31, for the following academic year. Further information regarding the procedure to be followed in applying for these scholarships may be obtained by writing to Dr. W. E. Taylor, Honorary Secretary, The Leonard Foundation, c/o Toronto General Trusts Corporation, 253 Bay Street, Toronto.

THE J. EDGAR MC ALLISTER FOUNDATION

Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1891, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mechanical, Chemical, Electrical and Metallurgy and Materials Science. Inquiries should be made in the Faculty Office.

THE JOHN WOLFE MC COLL MEMORIAL AWARDS

These six awards, two of which are open to students in the Faculty of Applied Science and Engineering, are the gift of the estate of the late John Wolfe McColl. The awards have a minimum value of $250 and a maximum of $750. Applicants must have obtained First Class Honours at the final examinations of the preceding year, whether Ontario Grade XIII or at the University of Toronto, demonstrate financial need and be enrolled or undertake to enrol in either Engineering Science or Chemical Engineering. Students seeking first admission to the University must submit applications for an award to the Registrar of the University on or before May 1. Students in the University must submit applications for an award to the Registrar of the University on or before October 15.

THE J. A. D. MC CURDY PRIZE

The J. A. D. McCurdy Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44) in honour of John Alexander Douglas McCurdy, a graduate of the School of Practical Science, who "made the first flight in Canada on February 23, 1909, with a heavier-than-air machine."

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in annual examinations of the Third Year in the subjects related to Aerodynamics.

The first award was made on the results of the examinations of the Session 1953–54.

THE GARNET W. MC KEE-LACHLAN GILCHRIST SCHOLARSHIP IN ENGINEERING SCIENCE

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a Scholarship in the First Year of the Course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual examinations of the First Year in the Course in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in honours in the Course. In order to receive payment the winner must register in the Second Year of the Course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations of 1947.

THE GARNET W. MC KEE-LACHLAN GILCHRIST GEOPHYSICS SCHOLARSHIPS

Financial assistance was received by Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, from certain organizations and individuals to help him in the prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. To this fund have been added additional amounts received from the estate of the late Garnet W. McKee and from the Hollinger Consolidated Gold Mines Ltd. They are awarded by the Senate, on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the Annual Examinations of 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $220 is awarded to the student in the Second Year in the Course of Engineering Science who obtains the highest aggregate standing at the examinations of the First and Second Years in the Course, provided always that the student obtains honour standing at the examinations of the Second Year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $165 is awarded to the student in the Second Year in the Course of Engineering Science who, of those students who elect to proceed in the Third Year in the Geophysics Option of the Course, obtains the highest aggregate standing at the examinations of the First and Second Years, provided always that the student obtains honour standing at the examinations of the Second Year, and excluding always the student to whom the First Lachlan Gilchrist Geophysics Scholarship has been awarded.

If in any year there is no student who has fulfilled the condition as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second Year in the Course in Engineering Science who obtains the second highest aggregate standing at the examinations of the First and Second Years of that Course,

provided always that such student obtains honour standing in the examinations of the Second Year.

THE ALEXANDER MAC LEAN SCHOLARSHIP

This scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A. (1908) who retired in 1954. The scholarship, of the value of $250, is awarded to a student in the Third Year of Geological Sciences, Faculty of Arts, or in the Third Year of Geological Engineering, Faculty of Applied Science and Engineering, who, obtaining not less than 75% in the work of the year, obtains the highest standing in the geological subjects common to the two courses.

The first award was made in 1955.

MAC LENNAN-MAC LEOD MEMORIAL PRIZE

The Graduating Class of 1910 has donated an annual prize, known as "The MacLennan-MacLeod Memorial Prize", in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug. MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of $25, is awarded to the First Year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual written examinations; or, in the event of more than one student obtaining equally high rank in Calculus, the award is made to the one of these who also has the highest standing in some other subject common to the competitors, such as Analytical Geometry, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in a subsequent year.

CHARLES GORDON MANNING PRIZE

The Charles Gordon Manning Prize was established by a bequest under the Will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the Prize.

The recipient must be enrolled in the Second Year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations specified for the award of that Scholarship, namely, obtaining honours in his final examinations and being one of the first three in his year by his standing at those examinations relative to the pass requirements in his Department and being "adjudged highest

of the three in general student activities and service in the University during his period of attendance."

The first award was made on the results of the Annual Examinations of 1954.

MARSLAND ENGINEERING LIMITED SCHOLARSHIP

The Marsland Engineering Limited Scholarship, the gift of Marsland Engineering Limited, has a value of $250. It is awarded to the student who, having been granted a Dominion-Provincial Student Aid Bursary in his First Year, is registered in Mechanical or Electrical Engineering and obtains the highest average percentage of marks, with honours, at the annual examination of the First, Second or Third Years in the session in which the award is made.

The first award was made at the annual examinations of 1954.

MASSEY-FERGUSON LIMITED SCHOLARSHIPS

Massey-Ferguson Limited has established two scholarships each of an annual value of $250, to be awarded on the recommendation of the Council of the Faculty of Applied Science and Engineering to students registered in the Fourth Year of the Courses in Mechanical Engineering or Industrial Engineering. In making the award academic achievement, financial need, extra-curricular activities and such other factors as may be deemed appropriate will be taken into consideration.

Application should be made to the Secretary of the Faculty not later than October 15.

JAMES L. MORRIS MEMORIAL PRIZE

The James L. Morris Memorial Prize is the gift of Mrs. J. H. Craig and Mr. J. R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career. Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For 43 years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal, power and bridge work.

This Prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second Year of the Course in Civil Engineering who obtains the highest aggregate percentage at the annual examinations of the First and Second Years of the course, provided always that the student obtains honour standing at the Examinations of the Second Year.

NORTHERN ELECTRIC UNDERGRADUATE SCHOLARSHIP

The Northern Electric Company Limited have established a Scholarship in the Faculty of Applied Science and Engineering and the Faculty of Arts of an annual value of $500. In this Faculty the scholar must be registered in the First, Second or Third Year of

Electrical Engineering, Mechanical Engineering, Engineering Science or Industrial Engineering. He must also (*a*) be a Canadian citizen or landed immigrant and (*b*) have a minimum of 75% or its equivalent in the previous annual examinations, in this or another recognized University. This scholarship is not tenable with other awards from commercial sources, or with awards stipulating subsequent employment as a condition (e.g. R.O.T.P.).

The award is made alternately in the two faculties, the first in the Faculty of Arts in 1959 and in the Faculty of Applied Science and Engineering in 1960 and in a similar manner thereafter. Application is not required.

THE ONTARIO HOCKEY ASSOCIATION WAR MEMORIAL SCHOLARSHIP

The Ontario Hockey Association War Memorial Scholarship, the gift of the Ontario Hockey Association, is to be awarded annually at the Grade XIII examination to an applicant whose father served overseas with the Canadian Forces in World War I.

The value of this scholarship is $100 in cash, with an allowance of the same amount on the tuition fee for each session.

In determining the award of the scholarship, the academic qualifications of the candidate shall be first taken into account, provided always that no candidate shall be eligible for an award who has not met all the conditions required by the University of candidates for admission scholarships generally; but, *cæteris paribus,* the award shall be made to a student who is in proved need of assistance.

The award shall be made by the Senate of the University upon the report of a committee to be appointed by the Senate, upon which committee there shall be always one member of the Staff of the University who shall be deemed to be representative of the Association.

Application should be made to the Registrar of the University on the regular scholarship application form not later than May 1.

ONTARIO MUNICIPAL ELECTRIC ASSOCIATION BURSARY

District No. 4 of the Ontario Municipal Electric Association has provided a Bursary of $300 in the Faculty of Applied Science and Engineering.

An applicant for the Busary must:

(*a*) be registered in the Fourth Year, Electrical Engineering;

(*b*) have good academic standing;

(*c*) be in need of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

PAULIN MEMORIAL SCHOLARSHIP

The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a graduate of this Faculty in 1907, was established in memory of his brother, John Cameron Paulin, a student of this Faculty, who was fatally injured in

1906 during a football practice. The scholarship, which has the value of the income from a capital fund of $10,000, approximately $475 annually, is awarded to a student who obtains high standing in the work of the first year in the Faculty of Applied Science and Engineering.

PROCTER AND GAMBLE BURSARY PLAN

Procter and Gamble Bursaries, the gift of the Procter and Gamble Company of Canada, are awarded annually to students in all years. Applicants must have at least Second Class Honours or better in the final examinations of the preceding year and demonstrate financial need. Applications must be submitted to the Registrar of the University on or before December 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO ADMISSION SCHOLARSHIP

The Association of Professional Engineers of the Province of Ontario has established an Admission Scholarship in Engineering of the value of $500. It is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Application must be made to the Registrar before May 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO SCHOLARSHIPS

The Association of Professional Engineers of the Province of Ontario offers Scholarships of a value of $250 in each of the First, Second and Third Years in the Faculty of Applied Science and Engineering in any course, to the students who, taking Honours, obtain the highest standing in the work of their respective years.

These scholarships will not be awarded to students who hold other scholarships.

PROFESSIONAL ENGINEERS GOLD MEDAL

The Association of Professional Engineers of the Province of Ontario has established in the Faculty of Applied Science and Engineering an award in the form of a gold

medal accompanied by a gift of technical books of an approximate value of $50. The award will be made to the student of the final undergraduate year in any course who, taking honours, obtains the highest weighted average percentage in the practical work and written examinations of the year.

RANSOM SCHOLARSHIP IN CHEMICAL ENGINEERING

The Ransom Scholarship in Chemical Engineering is presented by A. C. Ransom, Esq., of Toronto, for the purpose of encouraging and giving financial assistance to students who choose the field of Chemical Engineering. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount such as will be derived from the income of this sum. The first award was made on the results of the annual examinations of 1938.

The scholarship will be awarded annually to the student registered in the Course in Chemical Engineering who obtains the highest aggregate percentage of marks in the examinations of the First Year. The scholarship will be paid to the winner only if he proceeds to take his Second Year in the Course in Chemical Engineering in the University of Toronto.

J. E. REID MEMORIAL PRIZE

This prize, established in 1967 in memory of the late Professor J. E. Reid, is awarded to the student in the Fourth Year of the course in Electrical Engineering who, graduating with honours, achieves the highest aggregate marks in the Fourth Year examinations in the subjects pertaining to electronic communication.

THE RHODES SCHOLARSHIP

The Rhodes Trustees offer for award in the Province of Ontario two out of ten of the Rhodes Scholarships for Canadians, each of the value of £1,000 and tenable at Oxford University for a period of two years; in certain cases, a third year may be authorized.

Each candidate must be a British subject with at least five years domicile in Canada and unmarried; he must have passed his nineteenth but not twenty-fifth birthday on October 1 of the year *for* which he is elected; he must have completed the first year of his course at a Canadian university at the time of application.

A candidate may apply either for the province in which he has his private home or residence, or for the province in which he has taken his university course.

In that section of the will in which he defined the general type of scholar he desired, Mr. Rhodes mentioned four groups of qualities, the first two of which he considered most important.

(1) Literary and scholastic attainments;
(2) Qualities of manhood, truth, courage, devotion to duty, sympathy, kindliness, unselfishness, and fellowship;
(3) Exhibition of moral force of character and of instincts to lead and to take an interest in his fellows;

(4) Physical vigour, as shown by fondness for and success in outdoor sports.

Some definite quality of distinction, whether in intellect, character or personality, or in any combination of these, is the most important requirement. Financial need does not receive special consideration.

Forms of application and full information regarding these scholarships may be obtained from the Registrar, University of Toronto, or from the secretary of the Ontario Selection Committee, Alistair W. Gillespie, Esq., Suite 1602, 50 King St. W., Toronto. Selection is made in December for the following year and all applications must reach the provincial secretary before November 15 annually.

R.C.E. MEMORIAL SCHOLARSHIP

The Memorial Fund Committee of the Royal Canadian Engineers has established the R.C.E. Memorial Scholarship of a value of $125, open to students who have successfully completed their second to last year in the Faculty of Applied Science and Engineering or the School of Architecture.

A candidate must be

(*a*) a member in good standing of the Canadian Officers Training Corps and have successfully completed one summer season's training, or

(*b*) an ex-member of the Canadian Officers Training Corps who has successfunlly completed two years of C.O.T.C. Training and has transferred to the Canadian Army (Militia) or to the Canadian Army (Supplemental Reserve), or

(*c*) a member of the Canadian Army (Regular) attending University under the Regular Officers Training Plan.

Selection is made on the basis of academic standing and of qualities of leadership.

Application forms may be obtained from the office of the Registrar.

REGULAR OFFICER TRAINING PLAN

Tenable in approved degree courses, this plan is available to Canadian citizens who undertake to serve in the armed forces for at least four years after graduation. Accepted candidates will receive tuition, a book allowance of $125 and a living allowance of $187 per month during the academic session.

Application should be made to the Canadian Forces Recruiting Centre, 25 St. Clair Avenue West, Toronto 7.

HELEN E. ROGERS ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of Helen E. Rogers open to students entering any degree course in the University. Preference is given to applicants from outside Ontario but failing such candidates awards may be made to qualified Ontario students. Recipients must have a standing satisfactory to the Committee of Award on first admission and may continue to enjoy the scholarship in the upper years provided they maintain first class standing. The value in each year is a

minimum of $200 and a maximum of $1,500 dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

DON SALT MEMORIAL SCHOLARSHIPS

In memory of Donald John Salt, a graduate of the Faculty of Applied Science and Engineering and a practising geophysicist, the Canadian Exploration Geophysical Society has provided two scholarships of the value of $500 which are open to students in the Third and Fourth Years of certain courses in the Faculty of Arts and Science, and in Geological Engineering and the Geophysics option of Engineering Science in the Faculty of Applied Science and Engineering.

The award is made on evidence of the interest and ability of the applicant in relation to the field of mining geophysics.

Application should be made either to the Chairman of the Department of Physics or the Chairman of the Department of Geology by March 1 in the calendar year in which the award is to be made.

FREDERICK W. SCHUMACHER SCHOLARSHIP

The Frederick W. Schumacher Scholarship has been awarded in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must (*a*) be enrolled in the Second, Third or Fourth years in Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and (*b*) must have high academic standing.

Applications must be submitted to the University Registrar not later than October 15.

"SECOND MILE ENGINEER" AWARD

The Class of 3T5, convinced that a successful engineer must not only be professionally competent but also constantly aware of his responsibilities to humanity, and inspired by an address of President William E. Wickenden of the Case School of Applied Science, Cleveland, called "The Second Mile," which was based on the text from the Sermon on the Mount, "whosoever shall compel thee to go one mile, go with him twain" has established the "Second Mile Engineer" award. It is the desire of the donors to encourage undergraduates to participate fully in extra-curricular activities and to recognize the true importance of the more liberal subjects of the curriculum with the ultimate objective, on entering the profession, of becoming worthy Second Mile Engineers. The award comprises a grant of $200, a suitably inscribed presentation piece and an illuminated scroll, and is presented to a student in his final year.

An eligible group is chosen from those who have taken a prominent part in the affairs of the Faculty, either as office holders or in athletics. In making the award

consideration is given to academic standing, with special emphasis on the candidate's attainments in the cultural and humanistic-social studies. The subjects which are stressed are English of the First Year; Economics of the Second Year; and Political Science and Modern World History of the Third Year.

Particulars are furnished each session by the Class of 1935.

THE SIMPSONS-SEARS LIMITED (NORTHERN ONTARIO) SCHOLARSHIPS

These scholarships, the gift of Simpsons-Sears Limited, are open only to students of the Copper Cliff High School, The Sudbury High and Technical Schools, the Sturgeon Falls High School, the North Bay Collegiate Institute and Vocational School, the Kapuskasing High School and all the Secondary Schools along the Ontario Northland Railway. A scholarship of the value of $100 is available for each of the schools mentioned and an additional sum of $50 will be given to the student who obtains the highest percentage of the nine papers of Grade XIII selected in accordance with the regulations.

No scholarship will be awarded unless the candidate is in actual attendance in one of the colleges or faculties of the University and maintains a uniformly high standard to the satisfaction of the donors of the scholarships.

Application for these scholarships must be sent not later than May 15, to the Principal of the North Bay Collegiate Institute and Vocational School, from whom further information may be obtained regarding conditions of award.

WALLACE AWARD
SOCIETY OF AUTOMOTIVE ENGINEERS PRIZE

In memory of William Wallace, Professor of Mechanical Engineering, University of Toronto, the Ontario Society of Automotive Engineers offers an annual prize of the value of $100 to a student of the Fourth Year in any course whose thesis on a topic related to Automotive Engineering is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory.

SOCIETY OF CHEMICAL INDUSTRY MERIT AWARD

The Society of Chemical Industry Merit Award is made annually by the Society to the student in Fourth Year in the Department of Chemical Engineering who obtains the highest weighted average of marks in the results of the annual examinations for the year. The award is a gold key.

THE MURRAY F. SOUTHCOTE SCHOLARSHIP

Established by friends of the late Murray F. Southcote, a graduate of this Faculty (Aeronautical Engineering, 1950) this scholarship, which has a value of $100, is awarded in recognition of high standing at the Annual Examinations of the Third Year, in any course in the Faculty.

The first award was made in the Session 1964-65.

SPRUCE FALLS POWER AND PAPER COMPANY LIMITED SCHOLARSHIPS

The Spruce Falls Power and Paper Company Limited has established four Scholarships of a value of $400 each, two in the Second Year and two in the Third Year. They are awarded on the results of the Annual Examinations of the Second and Third Years to the students who obtain honour standing at the examinations of their respective years and are open to students in all courses in the Faculty. The first awards were made on the results of the examinations of 1951.

Each scholarship carries a grant of $150 to the University General Funds.

WALTER STERLING ADMISSION SCHOLARSHIPS

Established in memory of Walter Sterling, these scholarships are open to students entering any first degree course at the University of Toronto. Recipients must obtain First Class Honours standing on the nine Ontario Grade XIII papers required for admission, and may continue to enjoy the scholarships in each year of their course providing they maintain Honour standing. The value of the scholarship is from $200 to $1,500 annually, dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University on the regular scholarship application form. The statement of financial need should be completed if an award greater than $200 is desired.

THE WILLIAM STORRIE MEMORIAL SCHOLARSHIPS IN CIVIL ENGINEERING

Three Scholarships have been established by Mrs. William Storrie in memory of her husband, the late William Storrie, a Consulting Engineer on many municipal projects in Canada and for several years a special lecturer in the Faculty of Applied Science and Engineering, for students in Civil Engineering, as follows:

(*a*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Second Year in Civil Engineering.

(*b*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Third Year in Civil Engineering.

(*c*) Of a value of $200 to the student who obtains the highest standing in the annual examinations of the Fourth Year in the Municipal and Sanitary Option of the course in Civil Engineering.

In all cases the candidates shall have demonstrated qualities of integrity and shown promise of leadership in their profession.

The first awards were made for the Session 1956-57.

EDITH TYRRELL MEMORIAL BURSARY

The Women's Association of the Mining Industry of Canada has presented this Bursary, having the value of $600, annually, commencing in 1939, and named in memory of their founder and first president, Mrs. Edith Tyrrell. A medal donated by Dr. Tyrrell

accompanies this Bursary. The Bursary is awarded to a student entering the Third or Fourth Year in the Course of Metallurgy and Materials Science, or Geological Engineering; it may be awarded two years in succession to the same student, but will usually be awarded at the beginning of the Third Year. The award will be made by a special committee appointed by the Association on the following basis:

(*a*) In addition to mental capacity, the student must show leadership ability and give promise, through his activities, of becoming a worthwhile influence in the affairs of the profession and the community.

(*b*) While attention is given to scholastic ability, as evidenced by his academic standing, it is not the governing factor. He must, however, stand in the top quarter of his class.

(*c*) Special consideration is given to financial need.

Application must be made to the Secretary of the Faculty within one month of the opening of the academic year.

S. UBUKATA FUND

The S. Ubukata Fund for Japanese students was established to assist students from Japan proper to pursue a course of study at the University of Toronto. The fund provides grants of varying values on the basis of the information submitted by the applicants who:

(*a*) must be Japanese students from Japan proper;

(*b*) must register in the University of Toronto devoting full time to their studies;

(*c*) are able to satisfy admission requirements regarding English facility;

(*d*) are not holding other financial aid.

UNIVERSITY OF TORONTO ALUMNI ASSOCIATION WAR MEMORIAL SCHOLARSHIPS

Six scholarships are awarded annually by the University of Toronto Alumni Association to students entering first degree courses at the University of Toronto. The scholarships have a value of $500 annually, and are tenable for two years, providing satisfactory academic standing is maintained. They are awarded for general proficiency in Grade XIII, and in addition to academic performance the committee of award will take into consideration the candidate's relationship to active service in the Armed Forces of Canada, need of financial assistance, participation in extra-curricular activities and such other qualifications as may commend themselves to the committee. One scholarship will be available to a student whose home is not in the Province of Ontario.

Students resident in Ontario may apply on the general admission scholarship form which must be submitted to the Registrar of the University not later than May 1. Evidence of relationship to active service in the Armed Forces of Canada should be attached. Students resident outside Ontario may obtain the necessary forms from the Awards Department, Office of the Registrar, University of Toronto.

UNIVERSITY OF TORONTO GENERAL BURSARIES

The Board of Governors has established a fund to provide bursaries for deserving students who without financial assistance cannot continue their formal education. Further information may be obtained from the Secretary of the Faculty.

THE U.T.S. ENGINEERING SCHOLARSHIP

The U.T.S. Engineering Scholarship, the gift of R. A. Bryce, Esq., of the value of $250. The scholarship will be awarded by a committee of the Staff of the University of Toronto Schools to a student of the Schools who has completed the requirements for admission to and enrols in the Faculty of Applied Science and Engineering.

WALLBERG ADMISSION SCHOLARSHIPS

Two admission scholarships, each of a value of $500 are awarded annually from the income from the Wallberg Bequest on the recommendation of the Council of the Faculty to the two candidates who obtain the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to Council that this attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Applications must be submitted to the Registrar on the prescribed form by May 1.

WALLBERG UNDERGRADUATE SCHOLARSHIPS

These scholarships, four in number, of the value of $500 each, derived from the Wallberg Bequest, are awarded annually; two to students ranking first and second respectively at the annual examinations of the First Year; one to the student ranking first at the annual examinations of the Second Year; and one to the student ranking first at the annual examinations of the Third Year.

Any holder of one of these scholarships may not hold other awards listed in the index with an asterisk. The awards were first made on the result of the annual examination of 1947.

W. S. WILSON MEDALS

These medals have been provided in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal will be awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of his course.

The first awards were made in the Session 1962–63.

WILLIAM R. WORTHINGTON MEMORIAL SCHOLARSHIP

The William R. Worthington Memorial Scholarship, the gift of Miss Ida R. Worthington, in memory of her brother, William R. Worthington, DIP.(1904), B.A.SC.(1905), of the value of the income from a fund is awarded annually to the student of the Second Year in the course in Civil Engineering who ranks highest at the annual examinations of that year.

The first award was made at the examinations for the Session 1954–55.

LOAN FUNDS

From the loan funds mentioned below, small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must accordingly be restricted, both in amount and number, and principally to students in the Third and Fourth Years.

Enquiries for loans from any of the following funds should be made at the office of the Secretary of the Faculty.

Engineering Alumni Loan Fund
Engineering Society Loan Fund
Elizabeth Speller Memorial Fund
James W. Crocker Memorial Fund
Harry F. Bennett Educational Fund
S.A.E. – Canadian Section Loan Fund
Class of 2T7 (SPS) Memorial Loan Fund
Avro Aircraft Limited Engineering Loan Fund
The William Storrie Memorial Fund
3T6 Engineers Loan Association
4T0 Engineering Loan Fund
Women's Association of the Mining Industry in Canada Loan Fund
The Devonshire Loan Fund
Class of '09 Trust Fund
University of Toronto Alumni Loan Fund

CLASS OF 1936 LOAN ASSOCIATION

Members of the Class of 1936 have made arrangements to assist students in obtaining loans through regular banking facilities. Information may be obtained from the Secretary of the Faculty.

ENGINEERING ALUMNI LOAN FUND

The Engineering Alumni Association established in 1950 a loan fund to assist engineering students, especially in the Third and Fourth Years.

Applications for loans from this fund should be made to the Secretary of the Faculty.

ENGINEERING SOCIETY LOAN FUND

In 1932 the Engineering Society repaid to the Board of Governors a series of annual grants which, over a period of years, had been made to the Society for special purposes. The Board of Governors, appreciating this action, set aside this sum, to be known as the Engineering Society Loan Fund, to provide loans to students of the Faculty of Applied Science and Engineering. The administration of the fund is carried out by a Committee appointed by the Board. The fund is not large, and only small loans can be made to relatively few students. Further inquiries should be made at the office of the Secretary of the Faculty.

ELIZABETH SPELLER MEMORIAL FUND

Through the generosity of Dr. F. N. Speller, of the Class of 1893, the "Elizabeth Speller Memorial Fund" has been established to provide loans for worthy students of the Third and Fourth Years of this Faculty. Applications for loans from this Fund should be made to the Secretary of the Faculty.

JAMES W. CROCKER MEMORIAL LOAN FUND

This fund was established by Mrs. William Crocker in memory of her son, James W. Crocker, a graduate in Mining Engineering in 1938, who was killed in an accident in a mine in the same year.

HARRY F. BENNETT EDUCATIONAL FUND

This fund was established by subscription from members of The Engineering Institute of Canada in memory of the late Harry F. Bennett, M.E.I.C., who for six years prior to his death in 1946 was chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, and who accomplished so much in this field by untiring efforts.

One purpose of the fund is to make loans to deserving students who need financial assistance to enable them to study engineering sciences at university level, and who have proved themselves by successfully completing their first year in engineering or the equivalent.

Loans will be made largely on the basis of character and to men who seem likely to develop the high professional standards which are essential to leadership in engineering science. A student who has been aided by this fund should feel that high obligations are placed on him; obligations to the subscribers, to the trustees, and to those coming after him who in turn can receive help as his loan is repaid.

Application forms may be obtained at the Faculty Office. The regulations are simple and the application of any worthwhile student will be given immediate and careful attention.

SOCIETY OF AUTOMOTIVE ENGINEERS – CANADIAN SECTION LOAN FUND

The Society of Automotive Engineers – Canadian Section has established a loan fund of $1,200 in the Faculty of Applied Science and Engineering. Preference is given to students in good scholastic standing and engaged in studies relative to the automotive and aircraft industries, and to students in fourth, third and second years in that order. Particulars may be obtained from the Secretary of the Faculty.

AVRO AIRCRAFT LIMITED ENGINEERING LOAN FUND

Avro Aircraft Limited has established a Loan Fund of $3,000 to provide loans to engineering students requiring financial assistance. Application should be made to the Secretary of the Faculty.

THE WILLIAM STORRIE MEMORIAL FUND

The William Storrie Memorial Fund has been established by Mrs. William Storrie to provide loans to undergraduates in the course in Civil Engineering. Application should be made to the Secretary of the Faculty.

THE DEVONSHIRE LOAN FUND

This Fund has been established by Graduates and friends of Devonshire House to assist students in the Residence. Application should be made to the Office of the Dean of Devonshire House.

CLASS OF '09 TRUST FUND

The Class of '09 on the 50th Anniversary of their graduation made a sum of money available in the Faculty for financial aid to undergraduates, with preference to Second Year students. Inquiry should be made to the Secretary of the Faculty.

THE UNIVERSITY OF TORONTO ALUMNI LOAN FUND

This fund comes from subscriptions received originally in 1919 and in succeeding years from graduates of the University and is administered by the University of Toronto Alumni Association.

Loans are available to undergraduate and graduate students enrolled in a full time course at the University, in second and subsequent years.

Particulars may be obtained from The University of Toronto Alumni Association, Alumni House, 18 Willcocks Street, Toronto, or from the Secretary of the Faculty or School.

IX Discipline

A SUMMARY OF THE REGULATIONS OF THE CAPUT CONCERNING STUDENT DISCIPLINE

1. Subject to the general regulations of the Caput of the University regarding jurisdiction in matters of discipline the Council of University College, the governing bodies of the Federated Universities and Affiliated Colleges, and the Councils of the Faculties, Schools, and Institutes have disciplinary jurisdiction over the conduct of all students registered in these Divisions of the University in all matters of local or internal concern to these Divisions. Jurisdiction over the conduct of students while in residence regardless of the Division of the University in which they are registered is vested in the body administering the residence.

2. Jurisdiction concerning conduct likely to affect the interests of the University as a whole is vested in the Caput.

3. The Students' Administrative Council will be supported in the proper performance of all its obligations and duties as provided in its Constitution.

4. Where the appropriate body exercising disciplinary jurisdiction has found that a student of the University has engaged in conduct prejudicial to the interests of the University, the Caput may, in its discretion, suspend or expel such student from the academic privileges of the University. Every decision of the Caput involving the expulsion of a student from the University requires confirmation of the Board of Governors.

5. Any student who interferes with the personal liberty of another or who subjects another student to indignity or personal violence may be considered by the Caput or any other body exercising disciplinary jurisdiction in the University to have committed a breach of discipline.

6. Initiation ceremonies involving physical violence, personal indignity, interference with personal liberty, or destruction of property, may be deemed a breach of discipline by the Caput or any other body exercising disciplinary jurisdiction in the University.

7. Without limiting the disciplinary powers vested in the respective bodies exercising disciplinary jurisdiction as set forth in sections 1–7, the following are cited as illustrations of conduct which, in the past, has been considered a breach of discipline prejudicial to the interests of the University:

(i) The organising of a parade on the streets of the city or the taking part in such a parade without permission of the authorities.

(ii) The destruction or defacing of University property, raids on Residences or other University buildings, and the breaking into University buildings.

(iii) Rowdy and other forms of behaviour, either on or off the Campus, of such an objectionable nature as to bring the University into public disrepute.

8. Student Clubs and Associations

(a) The constitution of every society or association of students in the University and all amendments to such constitutions require to be approved by the relevant University authorities. The giving of approval, and the responsibility for the programmes of student societies and associations, shall rest as follows:

(i) With the authorities of the College, Faculty or School concerned where the membership of the student society or association is drawn from a single College, Faculty or School.

(ii) With the Board of Stewards of Hart House, where the student society or association is a Committee of Hart House and is controlled by the Board of Stewards of Hart House.

(iii) With the Caput, in the case of all other student societies and associations.

(b) No approval will be given by any of the authorities listed in (a) above to the constitution of any society or association of students if that constitution permits:

(i) Membership in the society or association to persons who are not students of the University, unless in the case of the societies listed in (a) (ii) above, where membership is open also to graduates of the University and members of the Faculty of the University.

(ii) Any action of discrimination based upon race, religion, or colour.

9. The name of the University is not to be used in connection with a publication of any kind without permission of the Caput.

OF THE FACULTY OF APPLIED SCIENCE AND ENGINEERING

E. A. Allcut, M.SC.(BIRM.), M.E., F.R.AE.S.,
Professor Emeritus of Mechanical Engineering

W. B. Dunbar, B.A.SC.,
Professor Emeritus of Engineering Drawing

C. E. Helwig, M.A.SC.,
Professor Emeritus of Civil Engineering

K. B. Jackson, B.A.SC., D.SC.(WATERLOO),
Professor Emeritus of Applied Physics

W. G. McIntosh, B.A.SC.,
Professor Emeritus of Mechanical Engineering

R. R. McLaughlin, M.A.SC., M.A., PH.D., D.SC.,
Professor Emeritus of Chemical Engineering

J. W. Melson, B.A.SC.,
Professor Emeritus of Surveying and Geodesy

C. F. Morrison, B.E.(SASK.), M.SC.(MCG.),
Professor Emeritus of Civil Engineering

E. A. Smith, M.A.(MCM.),
Professor Emeritus of Chemical Engineering

V. G. Smith, B.A.SC.,
Professor Emeritus of Electrical Engineering

G. F. Tracy, B.A.SC., S.M.(M.I.T.),
Professor Emeritus of Electrical Engineering

A. Wardell, B.A.SC.,
Professor Emeritus of Engineering Drawing

W. J. T. Wright, M.B.E., B.A.SC., B.A.,
Professor Emeritus of Engineering Drawing

XI Administrative Officers

1967–1968

THE UNIVERSITY

President: C. T. Bissell, M.A., PH.D., D. ÈS L., D.LITT., LL.D., F.R.S.C.
Acting President: J. H. Sword, M.A. *(1967-68 Session)*
Vice-Provost and Executive Assistant to the President: D. F. Forster, B.A., A.M.
Assistant to the President: N. S. C. Dickinson, C.D., B.A.

Vice-President and Provost: M. St. A. Woodside, M.A., LL.D.

Vice-President (Health Sciences): J. D. Hamilton, M.D., F.R.C.P.(C.)
Vice-President (Research Administration):
G. de B. Robinson, M.B.E., B.A., PH.D., F.R.S.C.

Chief Librarian: R. H. Blackburn, M.A., B.L.S., M.S., LL.D.

Executive Vice-President (Non-Academic): A. G. Rankin, B.COM.
Vice-President (Administration): F. R. Stone, B.COM., C.A.
Financial Analyst: G. L. Court, D.F.C., M.COM., C.A.
Secretary of the Board of Governors and
Director of Administrative Services: D. S. Claringbold
Director of Physical Plant: F. J. Hastie, B.SC., P.ENG.

Vice-President and Registrar: R. Ross, M.B.E., M.A.
Executive Assistant to the Vice-President and Registrar: W. Kent, M.A.

Director of Admissions: E. M. Davidson, B.A.
Director of Student Awards: Miss H. L. Reimer, B.A., B.PED.
Special Officer (Secondary School Liaison): J. R. H. Morgan, M.B.E., M.A., B.PAED., LL.D.
Director of Statistics and Records: J. H. Tusiewicz, M.A.SC., M.B.A.
Director of University Health Service: G. E. Wodehouse, M.C., M.D., F.R.C.P.
Assistant Director of University Health Service – Women: Miss F. H. Stewart, B.A., M.D.
Director of Placement Service: A. W. Headrick, M.A.

Director of International Student Centre: Mrs. K. Riddell, B.A.
Director of the Advisory Bureau: D. J. McCulloch, B.A., M.D., D.PSYCH., F.R.C.P.
Director of Housing Service: Mrs. M. G. Jaffary, B.A.

Director of University Extension: G. H. Boyes, M.A.

Director of University of Toronto Press: M. Jeanneret, B.A., LL.D.

Director of Information: K. S. Edey
Director of Alumni Affairs: J. C. Evans, B.A.
Director of Development: R. J. Albrant

Warden of Hart House: E. A. Wilkinson, B.A.
Director of Athletics and Physical Education – Men: W. A. Stevens, B.S.
Director of Athletics and Physical Education – Women (Acting)
Miss A. Hewett, B.ED., P.E.

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The University of Toronto issues the following calendars and other publications concerning courses of instruction given by the University, any one of which may be had on application to the Office of Admissions of the University, or to the Secretary of the Faculty, School or Institute about which information is sought.

GENERAL INFORMATION:	University of Toronto Handbook
ADMISSION INFORMATION:	Admission Awards
	Admission Circular
APPLIED SCIENCE AND ENGINEERING:	Faculty of Applied Science and Engineering
	Engineering at Toronto – descriptive brochure
	Diploma Course in Operations Research
ARCHITECTURE:	School of Architecture
	Landscape Architecture – descriptive brochure
	Graduate Work in Architecture – descriptive brochure
ARTS AND SCIENCE:	Faculty of Arts and Science
	Courses and Subjects in Arts and Science
	Diploma Course in Computing and Data Processing
BUSINESS:	School of Business – Graduate Programme in Business Administration
CHILD STUDY:	Institute of Child Study
DENTISTRY:	Faculty of Dentistry
	Courses for Graduates in Dentistry
	Dental Hygiene
EDUCATION:	The College of Education
	Graduate Degrees in Education*
EXTENSION:	Degree Courses in Extension
	Certificate Course in Business
	Certificate Course in Public Administration
	Certificate Course in Criminology
	Evening and Afternoon Courses in the Liberal Arts
	Business and Professional Courses
	Correspondence Courses
	Pre-School Education
FOOD SCIENCES:	Faculty of Food Sciences
FORESTRY:	Faculty of Forestry
GRADUATE STUDIES:	School of Graduate Studies
HYGIENE:	School of Hygiene
LAW:	Faculty of Law
LIBRARY SCIENCE:	School of Library Science
MEDICINE:	Faculty of Medicine
	Division of Rehabilitation Medicine
	Division of Postgraduate Medical Education
MUSIC:	Faculty of Music
	The Royal Conservatory of Music
	School of Music Year Book
	General Syllabus
	Pianoforte and Theory Syllabus
NURSING:	School of Nursing
PHARMACY:	Faculty of Pharmacy
PHYSICAL AND HEALTH EDUCATION:	School of Physical and Health Education
SOCIAL WORK:	School of Social Work

*Write to: Ontario Institute for Studies in Education, 102 Bloor Street West, Toronto 5, Ontario.

University of Toronto

Calendar 1969-1970
Faculty of Applied Science and Engineering

University of Toronto Press
1969

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23	24	25	26	27	28	29
30	31					

September

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

October

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

December

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Calendar 1969-1970

FALL TERM, 1969

July 1	Tuesday	Dominion Day. Buildings closed.
August 4	Monday	Civic Holiday. Buildings closed.
August 18	Monday	Students of the IV Year, Course 1, Option B, report at Survey Camp.
August 25	Monday	Students of the III Year, Course 1, report at Survey Camp.
September 1	Monday	Labour Day. Buildings closed.
September 2	Tuesday	Fall Examinations commence. Students of the III Year, Course 9, report at Survey Camp.
September 3	Wednesday	Students in II Year, Course 6, report for Analytical Chemistry Lab.
September 11	Thursday	Registration in person of the I Year from 9:30 a.m. to 12 noon and from 2:00 p.m. to 4:30 p.m. in the Galbraith Building. Meeting of Faculty Council.
September 12	Friday	Registration in person of the II Year from 9:30 a.m. to 12 noon and of the III Year from 2:00 p.m. to 4:30 p.m. in the Galbraith Building. Dean's address to the I Year at 9:00 a.m. in Convocation Hall. Preliminary instruction to the I Year.
September 13	Saturday	Registration in person of the IV Year from 9:30 a.m. to 12 noon in the Galbraith Building.
September 15	Monday	Lectures and laboratory work commence at 9:00 a.m. Opening address by the President to the students of all Faculties at 2:00 p.m. in Convocation Hall. Lectures and laboratory classes withdrawn from 1:45 p.m. to 3:10 p.m.
October 1	Wednesday	Meeting of Faculty Council.
October 10	Friday	Meeting of Senate.
October 13	Monday	Thanksgiving Day. Buildings closed.

November 4	Tuesday	Meeting of Faculty Council.
November 11	Tuesday	Remembrance Day.
November 14	Friday	Meeting of Senate.
December 3	Wednesday	Meeting of Faculty Council.
December 11	Thursday	IV Year Employment Interviews.
December 12	Friday	IV Year Employment Interviews. Meeting of Senate.
December 13	Saturday	IV Year Employment Interviews.
December 17	Wednesday	First Year Term Examinations commence.
December 19	Friday	Term ends at 5 p.m.
December 25	Thursday	Christmas Day. Buildings closed.

SPRING TERM, 1970

January 1	Thursday	New Year's Day. Buildings closed.
January 5	Monday	Spring term begins. Mid-session Examinations commence.
January 9	Friday	Meeting of Senate.
January 12	Monday	Meeting of Faculty Council.
January 15	Thursday	Last day for payment of the second instalment of fees.
February 3	Tuesday	Meeting of Faculty Council.
February 13	Friday	Meeting of Senate.
February 16 to February 20	Monday Friday	Study week. Lectures and laboratory classes withdrawn.
March 4	Wednesday	Meeting of Faculty Council.
March 13	Friday	Meeting of Senate.
March 27	Friday	Good Friday. Buildings closed.
April 2	Thursday	Meeting of Faculty Council.
April 10	Friday	Term ends at 5 p.m. Meeting of Senate.
April 20	Monday	Annual Examinations commence.
May 5	Tuesday	Meeting of Faculty Council.
May 8	Friday	Meeting of Senate.
May 18	Monday	Victoria Day. Buildings closed.

II The Faculty of Applied Science and Engineering

ADMINISTRATIVE STAFF

Dean: J. M. Ham, B.A.SC., S.M., SC.D.(M.I.T.)
Associate Dean: W. F. Graydon, M.A.SC., PH.D.(MINN.)
Assistant Dean and Secretary: J. A. Gow, B.A.SC.
Assistant Secretary: W. J. Dowkes, B.A.SC.

The Faculty of Applied Science and Engineering in the University of Toronto offers the widest range of undergraduate and postgraduate studies in engineering in Canada. The four year Bachelor of Applied Science (B.A.Sc.) undergraduate program is offered in Civil, Chemical, Electrical, Geological, Industrial and Mechanical Engineering, in Metallurgy and Materials Science and in Engineering Science. The Engineering Science program offers specific options in Aerospace, Chemical, Computer Science, Electrical, Geophysics, Materials Science, Nuclear and Thermal Power and Physics.

The Faculty offers, through the School of Graduate Studies, postgraduate programs for the Master of Applied Science (M.A.Sc.), the Master of Engineering (M.Eng.) and the Doctor of Philosophy (Ph.D.). Through the immense diversity of the resources of the University it is possible to do research in bio-engineering (engineering and medicine), in environmental engineering (urban planning and the control of pollution in air, water and land), in the history of technology, etc. This remarkable pattern of bridges linking the arts, sciences and professions in studies of man, his ideas and works adds a distinctive vitality and range to engineering at Toronto.

There are some 2300 undergraduate students and 600 postgraduate students. Undergraduates are taught not only by the staff of the Faculty but also by staff of University departments in Chemistry, Geology, Mathematics, Physics, English, History, Philosophy and Political Economy. On the staff of the Faculty alone there are some 160 professors.

From its historic beginnings in the School of Practical Science (S.P.S.) in the eighteen seventies, the Faculty has grown since 1906 as an integral and senior part of

the University. For students an important historical fact is that the Engineering Society, the student society of the Faculty, with its "Cannon" and "LGMB" band, is the oldest engineering organization of any formal kind in Canada.

The Faculty is located on the main campus in a rectangle bounded on the south by College Street, the west by St. George Street, the north by Convocation Hall and on the east by Taddle Creek Road where, in the days of Canadian Confederation there was indeed a creek so named.

The administrative offices are located in the southwest corner of the Galbraith Building at 35 St. George Street. Students and visitors may obtain information and assistance here.

SUMMARY OF STUDENTS IN ATTENDANCE — *Session 1968–69*

COURSE		1	3	4	5	6	7	8	9	TOTAL
Year	I	113	134	61	125	133	176	8	16	766
	II	66	102	93	63	110	172	9	13	628
	III	72	71	93	57	85	95	6	8	487
	IV	51	54	45	34	74	70	12	6	346
TOTAL		302	361	292	279	402	513	35	43	2242
Special Students										6
Diploma Course in Operations Research										9

III General Information Admission and Registration

Full details of the University of Toronto undergraduate admissions are contained in the Undergraduate Admission Circular 1969–70 obtainable on request from the Office of Admissions, University of Toronto, Toronto 181, and available in all Ontario secondary schools. Inquiries about admission to the Faculty of Applied Science and Engineering should be directed to the above-mentioned office.

The right is reserved to limit the number of students admitted to any course in the Faculty.

1. ADMISSION REQUIREMENTS

ONTARIO GRADE 13 REQUIREMENTS:

Standing in the following subjects, with an overall average of 70% for Engineering Science, and 64% for all other courses:

Mathematics (A and B); Physics; Chemistry; and an additional subject or subjects comprising 2 credits selected from the Grade 13 subjects approved for purposes of admission to the University.

ONTARIO GRADE 12 PRESCRIPTION:

Ontario Grade 13 candidates must also have Grade 12 standing in at least six subjects (excluding Physical Education). The subjects chosen must include at least five of the following subjects and at least one subject from each of the four groups. Commencing in 1970 this selection of subjects at the Grade 12 level will not be a requirement, but will be recommended as being appropriate.

(*a*) English

(*b*) French; German; Greek; Italian; Latin; Russian; Spanish

(*c*) Geography (Parts 1 and 2); History (Parts 1 and 2)

(*d*) Mathematics (Parts 1 and 2); Science (Physics and Chemistry)

2. APTITUDE AND ACHIEVEMENT TESTS

Ontario students will present the results of all standardized tests offered in the secondary schools. Other students may improve their competitive position by taking the aptitude test of the College Entrance Examination Board, Box 592, Princeton, New Jersey 08540, U.S.A.

3. EQUIVALENT CERTIFICATES

The following certificates are usually accepted as equivalent to Ontario Grade 13 although individual subjects cannot always be equated. Candidates offering Senior Matriculation programmes from provinces other than Ontario must offer at least five subjects and satisfy the subject requirements specified for the course of their choice. Specific details on subjects and standards required for the course must be requested well in advance of the application deadline.

CANADA:

Alberta, Manitoba, Nova Scotia, Saskatchewan – Grade 12.
British Columbia, New Brunswick – Grade 13.
Newfoundland – First Year Memorial University.
Prince Edward Island – First Year University at Prince of Wales College.
Quebec – Senior High School Leaving Certificate; appropriate C.E.G.E.P. program; English Catholic Senior High School Leaving Certificate (5th Year High – Grade 12). Other certificates will be considered.

ENGLAND, WEST INDIES, EAST AND WEST AFRICA

(*a*) General Certificate of Education showing either

(i) Passes in five subjects of which at least two must be passed at advanced level; or

(ii) Passes in four subjects of which at least three must be passed at advanced level.

In either case, passes are required in Physics, Chemistry, and an acceptable mathematical subject. At least two of these must be at advanced level.

or (*b*) School and Higher School Certificates, which are equated to the General Certificate of Education as follows, and accepted on that basis:

Credits on the School Certificate are accepted as ordinary level passes on the General Certificate of Education; subsidiary passes on the Higher School Certificate as ordinary level passes on the General Certificate of Education; and principal or main subject pasess on the Higher School Certificate as advanced level passes on the General Certificate of Education.

HONG KONG:

(*a*) General Certificate of Education or School and Higher School Certificates as stated above; or

(*b*) University of Hong Kong Matriculation Certificate, accepted on the same basis as General Certificate of Education.

(*c*) Hong Kong English School Certificate (from 1965 onward), renamed the Certificate of Education (English) in 1968, in conjunction with (*a*) or (*b*).

(*d*) Chinese University of Hong Kong Matriculation Certificate, in conjunction with (*a*) or (*b*).

Note: Hong Kong English School Certificates issued prior to 1965 are not acceptable for admission purposes.

UNITED STATES OF AMERICA:

First Year University credits (a minimum of 30 semester hours) in the required subjects from accredited institutions of higher learning. A United States High School Graduation Diploma will not normally admit a candidate to any course. Advanced Placement work will, however, be considered.

4. ENGLISH FACILITY REQUIREMENTS

All applicants are required to submit evidence of facility in English. Candidates whose mother tongue is not English may be required to meet an appropriate standard in a recognized English facility test. The following evidence is acceptable:

(*a*) The University of Michigan English Language Test. This test is available at the University of Toronto for residents of the Toronto area. Enquiries about writing the test in Toronto should be addressed to the Office of Admissions, Simcoe Hall, University of Toronto.

(*b*) The Certificate of Proficiency in English issued by the Universities of Cambridge or Michigan.

Information about writing the tests in (*a*) or (*b*) above in overseas centres may be obtained from the Office of Admissions, Simcoe Hall, University of Toronto.

The University is prepared to consider other evidence of English facility which may be submitted for evaluation to the Office of Admissions.

5. MATURE STUDENTS

Candidates 25 years of age or older who have lived in Ontario for a minimum period of one year may request special consideration if they have not completed the regular admission requirements in full. In order to be admitted to the Faculty of Applied Science and Engineering all such candidates must have Grade 13 or equivalent preparation in mathematics, physics and chemistry. Interested candidates should consult the Office of Admissions for further information.

6. APPLICATION PROCEDURES

All Candidates must submit an application form and supporting documents to the Office of Admissions, University of Toronto, Toronto 5.

Supporting documents include all final secondary school certificates held. These certificates must indicate the subjects studied and grades obtained. If a certificate is not available at the time of application, candidates must indicate the exact name of the certificate to be presented for admission, and the subjects included therein, as well as the approximate date available. A notarized English translation must accompany certificates which are in a language other than English or French.

In addition a student who has previously attended a University must submit the following:

(*a*) Official transcripts issued by the University or College previously attended,

giving in detail the courses completed, with the standing and grades in each. Transcripts or a supporting letter from the Registrar of the University or College must indicate that the candidate has been granted honourable dismissal and is eligible for re-admission to the institution concerned in the session for which he seeks admission to the University of Toronto;

(*b*) Official statements or calendars giving full information on the content of the University courses covered by the transcripts submitted.

For application forms and further information about admission requirements, consult the Office of Admissions, stating in the first letter what credentials will be offered with a listing of subjects and grades obtained.

The closing date for the receipt of applications is June 1. Only in circumstances which the Committee on Admissions deems exceptional will a late application be considered.

7. EARLY ADMISSION

(Ontario Grade 13 students only)

Ontario Grade 13 students with good school records may be offered admission as early as May 30.

Students wishing to be considered for Early Admission should ensure that their applications are forwarded by their schools not later than April 1.

8. CANDIDATES WHO HAVE PREVIOUSLY FAILED IN UNIVERSITY WORK

Candidates with a previous failure in university work may be considered individually on their merits; candidates with two previous failures are normally refused admission.

9. PROCEDURE FOR REGISTRATION

Detailed instructions concerning registration will be mailed to returning and newly admitted students before the beginning of each academic year.

10. HEALTH REQUIREMENTS

Every person admitted to the University as an undergraduate must, at the time of his or her first medical examination by the University Health Service, present satisfactory evidence of successful vaccination within three years prior to the date of the examination, or must be vaccinated by the examining physician.

COLLEGES

With the establishment of New College and Innis College, which are open to students of all faculties, it is now possible for students of the Faculty of Applied Science and

Engineering to become members of a college. Membership in a college is not obligatory, and application for membership is at the option of the student.

Students entering the First Year who are interested in becoming members of either college should indicate their choice in the space provided on the University's admission application form. A college fee of $15 is required upon acceptance.

The facilities of Innis College and New College are described below.

INNIS COLLEGE

Innis College was constituted on July 1, 1964, and admitted its first students in the following September. It is a multi-faculty college of the University of Toronto, and includes undergraduate students in all Faculties and Schools of the University.

A special feature is the Writing Laboratory. This service offers assistance to Innis College students in the skills and methods of writing essays and other academic reports. A staff of experienced teachers is available to give individual instruction.

In September, 1969 Innis College plans to introduce experimental courses which will focus on contemporary themes and problems.

The College has limited residential space available in houses on campus. Separate application for residence accommodation must be made directly to the Residence Co-ordinator of Innis College.

Students entering First Year will be invited to apply for membership after they have been accepted into their Faculty or School. Students entering the Second to Fourth Years who wish to join the College should obtain an application form from the Registrar, Innis College, University of Toronto.

A special college fee of $15 is payable to the Chief Accountant of the University of Toronto. This payment is made after the applicant has received notice of his acceptance by Innis College.

NEW COLLEGE

New College is a multi-faculty co-educational college; in addition to students from the Faculty of Arts and Science those from other Faculties and Schools are eligible for membership. This gives students from all divisions of the University the opportunity to participate in the activities of a college and to associate with students in other fields of study. Tutorial classes are provided for First Year students in some subjects.

The new building, centrally located on the west campus, provides academic, social and dining facilities for all members of the College and in addition accommodates nearly 300 male students in residence.

Students applying for membership in the College who wish accommodation in the Residence must apply on the prescribed form which may be obtained from the Dean of Students, New College.

RESIDENCE ACCOMMODATION

DEVONSHIRE HOUSE

Devonshire House, the University Residence for Men, accepts students from all Faculties. The facilities of the residence include a library, music listening room, music practice room, common rooms, kitchenettes, laundry room, television and games rooms. It does not have a dining hall. Members may take their meals at Hart House, Howard Ferguson Hall, or New College, all located nearby.

Application forms may be obtained from the Secretary to the Dean, Devonshire House, University of Toronto. Application should be made as early as possible.

NEW COLLEGE

The residence facilities of New College, and the procedure for application, are described in the entry under Colleges, above.

Each of the four Arts Colleges also maintains a Men's Residence, into which some engineering students may be accepted. Further information may be obtained from

University College – Dean of Men
Victoria College – Senior Tutor
Trinity College – Registrar, Trinity College
St. Michael's College – Dean of Men

HOUSING SERVICE

For the convenience of those students who are not able to find accommodation in the University and College residences, the University Housing Service maintains a listing of rooming houses, flats, apartments and homes. Information may be obtained by telephoning 928-2542.

Off-campus housing of this nature is not subject to University regulation. However every effort is taken to make the information on the accommodation as complete as possible and students are encouraged to assist in this effort by reporting on the quality of the accommodation that they have occupied.

CAMPUS CO-OPERATIVE RESIDENCE INCORPORATED offers residence and apartment accommodation for graduate and undergraduate students. Total occupancy is 300 in residence, half male, half female, and 50 in apartments. Meals are provided, and non-residents are invited to eat at the Co-op Dining Rooms. Since the University of Toronto has no official connection with Campus Co-operative Residence, Inc., inquiries should be addressed direct to Campus Co-operative Residence Incorporated, 395 Huron Street, Toronto 181, Ontario.

ROCHDALE COLLEGE offers student accommodation of varying forms. Single and double rooms, suites, and apartments will be offered at reasonable rates. Total accommodation

will be about 850 students, both male and female. A large cafeteria is contained within the building. Students may take advantage of the educational program of Rochdale College on either a full or part-time basis if they so desire. Since the University of Toronto has no official connection with Rochdale College, all inquiries should be addressed direct to Rochdale College, Reservations Office, 395 Huron Street, Toronto 181, Ontario.

TARTU COLLEGE

Tartu College is expected to open in September, 1969, to offer accommodation to single graduate and professional faculty students. 444 single rooms and 15 double rooms will be available. Groups of six will have their own cooking facilities. Single rooms will be $85 a month and doubles $75 a month. A rebate system brings the rents down to $70 and $60 per month respectively, if the residents do their own cleaning and stay the full 12 months. Tartu College is located at the corners of Madison Avenue and Bloor Street. Since the University of Toronto has no official connection with Tartu College, all enquiries should be addressed direct to Mr. G. C. Sloan, Reservations Office for Tartu College, 39 Prince Arthur Avenue, Toronto, Ontario. Telephone: 925-2420.

ST. ANDREW'S-UNIVERSITY DAY NURSERY

This day nursery, established and supported by the University of Toronto, the Graduate Students' Union and the Students' Administrative Council, provides pre-school education and day care facilities for children of University of Toronto students. Children aged two to five years are accepted.

The nursery, located at St. Andrew's United Church, 117 Bloor Street East, is well equipped and staffed and is licensed under the Day Nursery Act, Province of Ontario. It operates from 8:30 a.m. to 5:45 p.m. throughout the winter and summer academic sessions. Fees are reasonable, and noon meals and morning and afternoon snacks are provided.

Priority of enrolment is given to children of University students, although children of other members of the University community will be considered.

Information may be obtained from the nursery (telephone 921-7078) or from the School of Graduate Studies.

IV Fees, Deposits and Expenses

FEES

1. Undergraduate students in the Faculty of Applied Science and Engineering must pay annual fees according to the schedule listed below. The total fee in each case is made up of the academic fee and incidental fees; all incidental fees are payable in the first term.

Students will receive by mail in August a fees form and instructions for the payment of fees. In order to avoid delay in registration at the opening of the session it is recommended that at least the first term instalment of fees be forwarded by mail as early as possible in September.

Fees may be paid by certified cheque, money order or personal cheque payable to the University of Toronto at par, and mailed to the Chief Accountant, University of Toronto, Toronto 181.

2. Payment of at least the First Term instalment must be made on or before the opening day of the session. An admit-to-lectures card cannot be issued until the student has complied with this requirement.

3. The Second Term instalment of fees, if not already paid, is due on the opening day of the second term and must be paid not later than January 15. After this date an additional fee of $3 per month or portion thereof (not exceeding $10), will be imposed until the whole amount is paid. All fees for the session must have been paid in full before the student can be admitted to the annual examinations.

4. Adjustment of fees for students who withdraw is made up to the twenty-fourth week of the session.

5. Fees, residence dues and other charges set forth in this calendar are subject to change by the Board of Governors.

SCHEDULE OF FEES

Men

Academic Year	*Academic Fee	†Incidental Fees	Total Fee (if paid in one instalment)	First Term Instalment	Second Term Instalment
I–IV	$650	$67	$717	$392	$328

Women					
I–IV	$650	$39	$689	$364	$328

*The Academic Fee includes the following fees:
Tuition; Library and Laboratory Supply; one Annual Examination; Laboratory Fee; and Degree.
†These Incidental Fees include the following fees:
For men – Hart House; Students' Administrative Council; Athletic; Health Service; Engineering Society; Faculty Athletic Association.
For women – Students' Administrative Council; Athletic; Health Service; Engineering Society.

LATE REGISTRATION FEE

Any student who registers after the last date for normal registration in his or her own faculty or school is required to pay a late registration fee of $10 plus $1 for each day of delay to a maximum of $20.

EQUIVALENT CERTIFICATE FEE

Each student who has been admitted to the First Year upon a certificate or certificates granted outside the Province of Ontario and covering all or any part of the admission requirements, must pay a fee of $5.

ADVANCED STANDING FEE

Each student who has been admitted to advanced standing from another university or college, must pay a fee of $10.

SPECIAL STUDENTS FEES

The fee is $95 per subject, payable to the Chief Accountant.

SUMMARY OF STUDENTS' EXPENSES

The following approximate statement of expenses will give the student a general idea of the cost of obtaining an education in the Faculty of Applied Science and Engineering in the University of Toronto, exclusive of personal expenses:

1. Fees, see schedule page 16.
2. Board and Lodging, per week ..... $25 up
3. Books and instruments, per year ..... about $135

V Courses and Degrees

UNDERGRADUATE COURSES

The Faculty offers the following courses leading to the degree of Bachelor of Applied Science:

Civil Engineering (Course 1)
Mechanical Engineering (Course 3)
Industrial Engineering (Course 4)
Engineering Science (Course 5)
Chemical Engineering (Course 6)
Electrical Engineering (Course 7)
Metallurgy and Materials Science (Course 8)
Geological Engineering (Course 9)
Aerospace Engineering (offered as an option in Engineering Science. See page 56.)

The curricula of the various courses are set out in detail in Section VI. All courses require attendance for four academic sessions. Full-time attendance during the academic session is required, except in the case of students taking the First Year on a part-time basis through the Division of University Extension (see below).

FIRST YEAR — DIVISION OF UNIVERSITY EXTENSION

Commencing in the session 1969/70, the First Year program (Division A only) will be offered through the Division of University Extension for students interested in part-time evening study. Completion of this program qualifies the student for entry into the Second Year of all courses except Engineering Science. As there is no provision in the Division of University Extension for courses beyond the first-year level students wishing to complete their studies for the degree must enter into full-time study in the regular courses in the Faculty of Applied Science and Engineering.

Information regarding the First Year Extension Program may be obtained from the Degree Courses Section, Division of University Extension, 84 Queen's Park, Toronto 181.

GRADUATE STUDY AND RESEARCH

Facilities are available in the Departments of the Faculty for postgraduate study and research leading to the degrees of Master of Engineering (M.Eng.), Master of Applied Science (M.A.Sc.), and Doctor of Philosophy (Ph.D.). For further information see the Calendar of the School of Graduate Studies.

DIPLOMA COURSE IN OPERATIONS RESEARCH

A one-year diploma course in Operations Research has been offered since 1963 for those who have obtained a bachelor's degree in engineering, science, or mathematics. The diploma course is designed specifically to meet the needs of people who are presently employed in industry and who aspire to develop special skills in the design, analysis, and control of complex organizational systems. The course may not be offered in a particular session if conditions prevailing render it impracticable to do so.

Inquiries regarding the diploma Course in Operations Research should be directed to the Secretary, Faculty of Applied Science and Engineering.

SPECIAL STUDENTS

Graduates of the University of Toronto and of recognized universities who wish to take one or more undergraduate subjects may be registered as special students in the Faculty of Applied Science and Engineering, subject to the approval of the teaching department concerned. Application must be made to the Secretary of the Faculty.

INTERIM HIGH SCHOOL ASSISTANT'S CERTIFICATE TYPE A

Graduates of engineering courses may be admitted to Type A certificate courses at the College of Education, University of Toronto, if they submit official transcripts which indicate that they have sufficient academic credits.

Graduates of engineering courses who lack sufficient academic credits for admission to Type A courses at the College of Education may be eligible for admission to the Type B course and later for endorsement of the Type B certificate.

Inquiries regarding admission to the Type B course should be addressed to the Registrar, the College of Education, University of Toronto. Inquiries regarding endorsement of Type B certificates or admission to Type A certificate courses should be addressed to the Director, Committee on Advanced Standing, the College of Education, University of Toronto.

ASSOCIATIONS OF PROFESSIONAL ENGINEERS

Graduation from the Faculty of Applied Science and Engineering leads to registration as a Professional Engineer in the various Associations of Professional Engineers throughout Canada.

VI Curriculum

In this era of rapid technological change, the professional role of engineering is to build bridges between the world of science and the world of men, and to do so with ingenuity, economy and sensitivity. The talent of the engineer is an amalgam of curiosity, physical insight, capacity for mathematical analysis, ability to work with people and to develop effective designs to achieve particular goals.

The early years of the four-year curriculum are designed to give students a command of the basic scientific principles upon which effective solutions to engineering problems are based. Although specialization into particular fields of study increases in the third and fourth years, the essential purpose of every academic program is to open the student's mind out to those general qualities which distinguish good engineering of any kind. These qualities transcend in importance the particular subject content in which they are projected.

On the following pages of this section, the curriculum for each course is set forth in detail. The time devoted to lectures and practical work is indicated as accurately as possible, but is subject to modification as occasion may require. The program and regulations regarding the courses of study and examination, contained in this Calendar, hold good for this academic year only, and the Faculty of Applied Science and Engineering does not bind itself to adhere for the whole period of a student's course to the conditions here laid down.

Communications relating to curricula, instruction, and examinations in the Faculty of Applied Science and Engineering should be sent to the Secretary of the Faculty.

For information regarding the courses of study leading to the post-graduate degrees, Master of Engineering, Master of Applied Science, and Doctor of Philosophy, see the calendar of the School of Graduate Studies, which gives full particulars.

First Year Studies

Chairman For First Year Studies:

P. E. Burke, B.E. (N.S. TECH.), M.A.SC.

Coordinating Staff

V. C. Hamacher, B.A.SC.(WATERLOO), M.SC.(QUEEN'S), PH.D.(SYR.) Department of Electrical Engineering
E. W. Domville, B.A., PH.D. Department of English
R. A. Ross, M.A., PH.D. Department of Mathematics
S. Sandler, M.A.SC. Department of Chemical Engineering
G. T. Will, M.A.SC. Department of Civil Engineering
A. Straughen, B.SC. (LOND.) M.A.SC. Department of Electrical Eng.
G. D. Scott, M.A., PH.D. Department of Physics
I. W. Smith, M.A.SC. Department of Mechanical Engineering
C. A. Wrenshall, B.E. (SASK.) Department of Civil Engineering

FIRST YEAR STUDIES

The First Year program is designed to build a strong foundation in the basic disciplines which underlie the whole field of engineering. There are two First Year curricula – Division A, the standard curriculum and Division B, the enriched curriculum for students intending to pursue the Engineering Science program. Admission to the Division B curriculum is granted only to students with better-than-average ability in mathematics and the sciences. (See page 9 for admission requirements).

Students entering Division A must elect one of the following courses in which they expect to continue in second year – Civil Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Electrical Engineering, Metallurgy & Material Science, and Geological Engineering. Subject to the availability of places, a student who successfully completes the First Year in Division A may request to transfer to any other course within that Division.

Students who complete the First Year in Division B with a weighted average of 66% or higher may continue in the Engineering Science program in the second year. Those who achieve a weighted average between 60% and 66% may continue

without condition into the second year of any other course in the Faculty, except Engineering Science. The First Year in Division B may not be repeated without the special permission of the Council of the Faculty.

Students wishing to transfer to a different course at the end of the first year should make application to the Secretary of the Faculty not later than July 15, 1969.

FIRST YEAR CURRICULUM — DIVISION A

Civil Engineering
Mechanical Engineering
Industrial Engineering
Chemical Engineering
Electrical Engineering
Metallurgy and Materials Science
Geological Engineering

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Chemistry	600, 601	2	3	2	3
Engineering Graphics	135	1	3	1	3
English	2110	2	—	2	—
Mathematics:					
Algebra and Analytic Geometry	2410	2	1	2	1
Calculus	2411	2	1	2	1
Mathematical Applications and Computer Programming	13	½	2	½	2
Physics:					
Electricity	700	2	¾	2	¾
Applied Mechanics	100	2	¾	2	¾
Structure and Properties of Matter	2501	2	1½	2	1½
Engineering Seminars	11	—	½	—	½

FIRST YEAR CURRICULUM — DIVISION B
Engineering Science

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemistry	602, 601	2	3	2	3
Engineering Graphics	135	1	3	1	3
English	2110	2	—	2	—
Mathematics:					
Algebra and Geometry	2415	2	3	2	3
Calculus	2416	2		2	
Computer Programming	3310	—	—	1	1
Physics:					
Electricity	701	2	—	2	—
Statics	101	2	—	—	—
Properties of Matter; Mechanics and Heat	2511, 2512	2	2½	2	2½
Engineering Seminars	11	—	½	—	½

Civil Engineering

STAFF OF THE DEPARTMENT

Professor and Chairman of the Department:
T. C. Kenney, B.ENG.(MC.G.), D.I.C.(IMP.), M.SC.(LOND.), PH.D.(LOND.)

Associate Professor and Assistant Chairman of the Department:
S. M. Uzumeri, B.A.SC., M.A.SC.

Professors:
F. A. DeLory, B.ENG.(MC.G.), M.A.SC., D.I.C.(IMP.), PH.D.(LOND.)
M. W. Huggins, B.A.SC., M.A.SC.
R. H. Mills, B.SC.(WITWATERSRAND)
H. R. Rice, B.SC.(QU.)

Associate Professors:
J. D. Barber, C.D., B.A.SC., M.A.SC.
A. P. Bernhart, DIP. ING.(GRAZ.), DR.TECH.(GRAZ.) (On sabbatical leave)
R. A. Collins, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
A. C. Davidson, B.SC., C.E., B.SC., E.E.(MAN.), M.A.SC.
M. M. Davis, B.SC.(QU.), M.SC.(PURDUE)
H. R. Frizzle, B.SC., E.E.(N.S.TECH)
B. J. Haynes, B.A.SC.
C. Hershfield, B.SC., C.E.(MAN.), M.A.SC.
P. H. Jones, B.A.SC., M.S.(NORTHWEST.), PH.D.(NORTHWEST.)
D. J. L. Kennedy, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
H. L. Macklin, B.A.SC.
E. I. Robinsky, B.A.(BEIRUT), B.SC.(BEIRUT), M.S.(HARVARD), PH.D.
J. Schwaighofer, DIP. ING.(GRAZ.), M.S.(PENN. ST.), PH.D.(PENN. ST.), DR. TECH.(GRAZ.)
K. A. Selby, B.A.SC., M.B.A., PH.D.(ILL.)
R. M. Soberman, B.SC.(DALH.), S.M.(M.I.T.), PH.D.(M.I.T.) (*on leave of absence*)

J. Vlcek, B.SC.F.(N.B.), M.A.SC.
C. A. Wrenshall, B.E.(SASK.)
P. M. Wright, B.E.(SASK.), M.SC., PH.D.(COLORADO)

Assistant Professors:
S. J. G. Bird, B.A.SC., M.A.SC.
M. P. Collins, B.E. (CANTERBURY), PH.D. (N.S.W.)
R. C. Gunn, B.A.SC., M.A.SC.
G. W. Heinke, B.A.SC., M.A.SC., PH.D.(MCM.)
K. Meipoom, B.A.SC., M.A.SC.
V. R. Riley, B.A.SC., PH.D.(CANTAB.)
G. K. Rodgers, B.A.SC., M.SC.(U.B.C.), PH.D.
G. N. Steuart, B.SC.(SASK.), M.SC.(CALIF.)
J. Timusk, B.A.SC., M.A.SC., PH.D. (LOND.)
A. K. F. Turner, B.SC.(QU.), M.A.(COLUMBIA), PH.D.(PURDUE)
G. T. Will, B.A.SC., M.A.SC.

Lecturers:
V. P. Borecky, DIP. ING.(PRAGUE), M.A.
E. Karuks, B.A.SC., M.A.SC.
R. G. Rice, B.A.SC., M.SC(M.I.T.)

CIVIL ENGINEERING

Course 1

The course in Civil Engineering is broad and comprehensive. It is designed to produce an adequate basic understanding of the technical aspects of the principal fields (structural, municipal and sanitary, transportation, surveying) in which Civil Engineers function with at least an acceptable level of competence in the activities (including executive and administrative) involved in each of those fields; and to provide for the acquisition, by the student, of superior competence in the particular field of his choice. To encourage a well-rounded education non-technical subjects and humanities are included. The objective of the program as a whole is the well-informed creative engineer possessing innovative and directive capabilities.

The curriculum for II, III and IV Year has been substantially revised for the 1969/70 and subsequent sessions. To phase in the revisions the new curriculum will apply to II Year only and an interim curriculum will apply to III and IV Year for the 1969/70 session. For the 1970/71 and subsequent sessions the new curriculum will apply to all three years. A wide range of technical electives will be available for the 1970/71 and subsequent sessions. It is also expected that there will then be available a number of non-technical electives, given by other faculties of the University, as alternatives to the prescribed non-technical subjects.

For the First Year curriculum see Division A, page 22.

SECOND YEAR CIVIL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Calculus	2420s	2	1	2	1
Computer Programming	145	2	2	—	—
Design of Structures	111	—	—	2	2
Economics	2720	2	—	2	—
Engineering Materials	109s	2	—	2	3
Engineering Mechanics	108	—	—	2	—
Engineering Presentation	138	1	3	—	—
Environmental Engineering	180	—	—	2	—
Geology	2900	—	—	2	2
Practical Experience	20	—	—	—	—
Strength of Materials	110	3	—	—	—
Surveying	153	2	1½	1	1½
The Engineer & His Environment	137	1	3	1	3

THIRD YEAR CIVIL ENGINEERING (*Session 1969–70 only*)

Design of Structures	111	2	2	—	—
Design of Determinate and Indeterminate Structures	112	2	2	3	2
Engineering Materials	113	2	—	—	—
Engineering Mathematics	142	3	2	—	—
Environmental Engineering	180	—	—	2	—
Fluid Mechanics and Hydraulics	333	2	—	2	3
History	2330				
or	2332	2	—	2	—
or Political Science	2730				
Municipal Engineering	182	—	—	2	2
Practical Experience	20	—	—	—	—
Probability and Statistics	141	2	—	—	—
Soil Mechanics and Foundations	191	2	1½	2	1½
Survey Camp	158	—	—	—	—
Transportation Systems	185	—	—	3	2

FOURTH YEAR CIVIL ENGINEERING (*Session 1969–70 only*)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Construction Management	130	—	—	2	—
Engineering Law	3440	1	—	—	—
English	2140	1	—	1	—
Hydraulic Engineering	343	2	3	—	—
Philosophy and Science	2040	2	—	—	—
And one of the following options:					
OPTION 1A (Structural)					
Behaviour and Design of Steel Structures	118	2	2	2	2
Mathematical Applications	140	—	—	2	1½
Reinforced Concrete I	116	2	3	2	3
Soil Mechanics and Foundations	192	2	—	1	2
Structural Theory II	119	2	2	3	2
Thesis Project and Mechanics of Materials Laboratory	40, 120	—	4	—	4
Elective		—	—	3	2
OPTION 1B (Surveying)					
Astronomy	172	—	—	1	3
Engineering and Legal Surveys	174	1	—	2	—
Geodesy and Electronic Surveying	175	2	1½	2	3
Geodetic Adjustments	168	1	3	1	3
Photogrammetry II	170	1	3	1	1½
Structural Engineering II	122	2	4½	2	3
Survey Camp	167	—	—	—	—
Town and Regional Planning	3540	1	3	1	3
Thesis	40	—	—	—	1
OPTION 1C (Geotechnical, Municipal and Transportation)					
Mathematical Applications	140	—	—	2	1½
Reinforced Concrete I	116	2	3	2	3
Soil Mechanics and Foundations	192	2	—	1	2
Thesis	40	—	2	—	4½
Elective		3	2	—	—
Elective		3	2	—	—
Elective		—	—	3	2
Elective		—	—	3	2

ELECTIVE SUBJECTS

Students, in consultation with an assigned staff member, are free to choose elective subjects from those listed below. A subject shown may not be offered if the enrolment for that subject is below a minimum number of students. With the approval of the Chairman of the Department, a student may also choose subjects offered outside the department. All subjects listed below will have a weight equivalent to three hours lectures and two hours laboratory per week for one term.

*First Term Electives**	
Air Photo Interpretation	189
Engineering Geology	194
Pollution Control Engineering	183
Traffic Engineering	187
*Second Term Electives**	
Reinforced Concrete II	117
Foundations and Earthworks	193
Municipal Engineering	182
Transportation Engineering	188

*In special cases, depending upon student interest and staff availability, one or more electives *may* be offered both terms, or not at all.

THIRD YEAR CIVIL ENGINEERING (*Commencing 1970/71*)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Design of Determinate and Indeterminate Structures	112	2	2	3	2
Fluid Mechanics & Hydraulics	333	2	—	2	3
Engineering Mathematics	142	3	2	—	—
Municipal Engineering	182	—	—	2	2
Practical Experience	20	—	—	—	—
Probability and Statistics	141	2	—	—	—
Soil Mechanics and Foundations	191	2	1½	2	1½
Survey Camp	158	—	—	—	—
Transportation Systems	185	3	2	—	—
History	2330				
	or 2332	2	—	2	—
or Political Science	2730				
Elective		—	—	3	2

FOURTH YEAR CIVIL ENGINEERING (*Commencing 1970/71*)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Administration and Management	133	2	—	—	—
Public Speaking	132	—	2	—	—
Thesis	40	—	4	—	8
English } One of {	2140	1	—	1	—
Philosophy of Science } One of {	2040	2	—	—	—
Elective		3	2	—	—
Elective		3	2	—	—
Elective		3	2	—	—
Elective		—	—	3	2
Elective		—	—	3	2
Elective		—	—	3	2

Elective Subjects

Construction Engineering
Advanced Strength of Materials
Indeterminate Structures
Reinforced Concrete
Design of Steel Structures
Hydrology & Water Resources
Pollution Control Engineering
Hydraulic Engineering
Urban & Regional Planning
Traffic Engineering
Transportation Engineering
Air Photo Interpretation
Foundations & Earth Work
Engineering Geology
Photogrammetry
Geodetic Control Surveys
Engineering Applications of Surveying
Advanced Engineering Materials

Mechanical Engineering

STAFF OF THE DEPARTMENT

Professor and Head of the Department:
G. R. Lord, B.A.SC., S.M.(M.I.T.), PH.D.

Professors:
W. D. Baines, B.SC.(ALTA.), M.S., PH.D.(IOWA)
F. C. Hooper, B.A.SC., D.I.C.(LOND.)
P. B. Hughes, B.SC.(MCG.)
L. E. Jones, B.SC.(C.E.) (MAN.), M.A.SC., PH.D.
F. P. J. Rimrott, DIP. ING.(KARLSRUHE), M.A.SC., PH.D.(PENN. STATE), DR. ING.(DARMSTADT)
I. W. Smith, M.A.SC.

Associate Professors:
A. B. Allan, M.A.SC.
J. F. Keffer, M.A.SC., PH.D.
H. J. Leutheusser, DIP. ING.(KARLSRUHE), M.A.SC., PH.D.
J. VandeVegte, DIP. ING.(DELFT), M.A.SC., PH.D.

Associate Professor (visiting):
R. C. Fenton, DIP. ING.(BUD.), PH.D.(N.S.W.)

Assistant Professors:
A. H. Abdelmessih, B.M.E.(CAIRO), M.S.(OKLAHOMA STATE), PH.D.
D. L. Allen, B.SC.(DAL.), B.E.(N.S. TECH.), M.A.SC., PH.D.
J. S. Ansari, B.E.(OSMANIA), M.S.(PURDUE), PH.D.(PURDUE)
I. G. Currie, B.SC.(STRATHCLYDE), M.A.SC.(B.C.), PH.D.(CAL.I.T.)
G. E. Godfrey, M.A.SC.
D. F. James, B.SC.(QUEEN'S), M.S.(CAL. TECH.), PH.D.(CAL. TECH.)
D. S. Scott, B.SC.(QUEEN'S), M.SC.(QUEEN'S), PH.D.(NORTHWESTERN)
P. S. Shen, B.SC.(LOND.), M.SC.(BIRMINGHAM), PH.D.(LOND.)
B. Tabarrok, B.SC.(WOLVER. & STAFF.), D.PHIL.(OXON)
C. A. Ward, B.SC.(TEX.), PH.D.(NORTHWEST.)

Special Lecturer:
F. E. Burke, B.A.(LOND.).

MECHANICAL ENGINEERING

Course 3

Traditionally associated with the art and science of power generation and the machines and devices by which power is usefully applied and controlled, Mechanical Engineering, like other branches of the engineering profession, participates actively in the advancement of knowledge and interprets this knowledge in the design and development of practical systems.

In manufacturing industry, in the transportation and power utilities, in the high-performance field of air and space engineering, or in engineering aspects of major works and structures, the mechanical engineer finds professional occupation, either as employee or consultant. His responsibility will generally be for the superintendence of operations and personnel, for the design of products and processes, and may include the administration of enterprises.

The curriculum in Mechanical Engineering provides an analytical training in mathematics and the physical sciences designed as a disciplinary basis for active professional practice. Recognition is given, however, to the purer scientific and philosophical concepts essential to postgraduate study and research.

For the First Year curriculum see Division A, page 22.

SECOND YEAR MECHANICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Calculus	2420	2	1	2	1
Circuit Theory	717	2	1½	—	—
Design of Machine Elements	356, 357	—	—	2	3
Differential Equations	380	—	—	2	1
Dynamics	351, 354	3	1½	—	—
Economics	2720	2	—	2	—
Electrical Measurements	718	—	—	2	1½
Materials Science	837	2	—	2	1½
Mechanics of Materials	107, 104	3	—	1	3
Probability and Statistics	2422	2	1	—	—
Theory of Machines	358	—	—	2	3
Practical Experience	20	—	—	—	—

THIRD YEAR MECHANICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Dynamics Measurements Laboratory	362	—	3	—	3
Engineering Design	363, 364	—	—	2	3
Engineering Mathematics I	386	3	1	3	1
Electric Machines	747	—	—	2	3
Electronics	743	2	3	—	—
Fluid Mechanics I	334	2	—	2	3
Heat Engineering	308	2	—	—	—
Heat Engineering Laboratory I	310	—	3	—	3
Systems Dynamics	360	1	—	1	—
Engineering Thermodynamics	309	2	—	2	—
Vibrations	361	2	—	—	—
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR MECHANICAL ENGINEERING

Applied Fluid Mechanics	344	2	1½	2	1½
Applied Mechanics	367, 368	2	1½	2	1½
Control Systems	391, 392	2	1½	2	1½
Engineering Law	3440	1	—	—	—
English	2140	1	—	1	—
Heat Transfer	319	2	—	2	—
Heat Engineering Laboratory	320	—	1½	—	1½
Numerical Analysis	2443	—	—	2	—
Philosophy of Science	2040	2	—	—	—
Thesis	40	—	3	—	3
and two of:					
Engineering Mathematics II	390	2	—	2	1½
Fluid Mechanics II	346	2	—	2	1½
Manufacturing Science	374	2	—	—	—
Science of Design	375	—	—	2	1½
Microscopic Thermodynamics	322	2	—	2	1½
Thermal Power Generation	323	2	—	2	1½

Industrial Engineering

STAFF OF THE DEPARTMENT

Professor and Chairman of the Department:
B. Bernholtz, M.A., PH.D.(CAL. TECH.)

Associate Professor and Assistant Department Chairman:
R. W. P. Anderson, M.A.SC.

Professors:
J. W. Abrams, A.B.(CALIF.), PH.D.(CALIF.)
P. J. Foley, M.A.(GLASGOW)
A. Porter, M.SC.(MANCH.), PH.D.(MANCH.) (*on leave for the session*)

Associate Professors:
S. H. Cohn, M.A.
T. A. Lambe, B.A.SC.(U.B.C.), M.SC.(STAN.), PH.D.(STAN.)
J. G. C. Templeton, B.A., A.M.(PRINC.), PH.D.(PRINC.)

Assistant Professors:
J. A. Buzacott, B.SC.(SYDNEY), B.E.(SYDNEY), M.SC.(BIRMINGHAM), PH.D.(BIRMINGHAM)
A. A. Cunningham, M.A.(OXFORD), PH.D.(ADELAIDE)
A. Mowshowitz, S.B.(CHICAGO), S.M.(MICH.), A.M.(MICH.), PH.D.(MICH.)
M. J. M. Posner, B.A.SC., PH.D.

Special Lecturers (part-time):
W. Davidson, B.A.SC., M.COM.
J. M. Tusiewicz, B.SC.(ENG.)(LOND.), M.A.SC., M.B.A.

INDUSTRIAL ENGINEERING

Course 4

The modern view of Industrial Engineering is that of a field concerned with the analysis, design improvement and operation of integrated systems of men, materials and equipment. This concept crystallized when it became clear that certain modern technical fields, including operational research, control theory, computer science, probability and statistics, systems theory and human factors engineering, constituted a body

of knowledge particularly useful in the operation and management of modern business, industry and government.

As a logical outcome of this development, the course in Industrial Engineering was established in 1958 to provide graduates in engineering specializing in the theory and practice of these subjects. This specialization rests upon a substantal foundation in science and mathematics, in fundamental engineering disciplines including fluid mechanics, applied thermodynamics, electric science, mechanics of materials, materials science and automation, and in such subjects as economics, organizational structure, financial control and the behavioural sciences.

For the First Year curriculum see Division A, page 22.

SECOND YEAR INDUSTRIAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Calculus	2420	2	1	2	1
Computer Programming I	422	1	1½	1	1½
Economics	2720	2	—	2	—
Electrical Engineering	719, 720	2	3	2	3
Elements of Industrial Engineering	414	2	—	2	—
Materials Science	834	2	—	2	3
Mechanics of Materials	102, 104	2	3	2	—
Probability and Statistics I	2423	2	2	2	2
Practical Experience	20	—	—	—	—

THIRD YEAR INDUSTRIAL ENGINEERING

Accounting	2734	2	—	2	—
Computer Programming II	423	1	1½	1	1½
Control Engineering	394	—	—	2	3
Differential Equations	2432	2	1½	2	1½
Fluid Mechanics and Thermodynamics	337	2	3	—	—
Numerical Analysis	2433	2	1½	2	1½
Operational Research I	424	2	2	2	2
Probability and Statistics II	2430	1	1½	1	1½
Practical Experience	20	—	—	—	—
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR INDUSTRIAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Automatic Control of Processes	415	2	—	2	—
Engineering Law	3440	1	—	—	—
English	2140	1	—	1	—
Industrial Engineering Seminar	417	—	1	—	1
Management Science	418	2	1½	2	1½
Operational Research II	419	3	3	3	3
Philosophy and Science	2040	2	—	—	—
Thesis Project	40, 421	—	6	—	6
and one subject from each of Groups 1, 2, 3 and 4:					
GROUP 1					
Human Factors Engineering and Equipment Design	425	2	—	—	—
Man as an Individual	426	2	—	—	—
GROUP 2					
Man as a Machine	427	—	—	2	—
Organizational Psychology	428	—	—	2	—
GROUP 3					
Systems Theories I	429	2	1½	—	—
Manufacturing Science	374	2	—	—	—
GROUP 4					
Systems Theories II	430	—	—	2	1½
Science of Design	375	—	—	2	1½

Engineering Science

MEMBERS OF THE DIVISION

Chairman of the Division:
B. Etkin, M.A.SC., F.C.A.S.I. (Professor of Aerospace Engineering)

Members of the Division:
K. T. Aust, M.A.SC., PH.D. (Professor of Metallurgy and Materials Science)
P. P. Biringer, DIP. ING(BUD.), M.SC.(STOCKHOLM), PH.D. (Professor of Electrical Engineering)
G. F. D. Duff, M.A., PH.D., F.R.S.C. (Professor and Head of the Department of Mathematics)
W. F. Graydon, M.A.SC., PH.D.(MINN.), (Professor of Chemical Engineering)
J. N. P. Hume, M.A., PH.D. (Professor of Physics and Computer Science)
R. L. Armstrong, M.A., PH.D. (Professor of Physics)
J. VandeVegte, DIP. ING.(DELFT), M.A.SC., PH.D. (Professor of Mechanical Engineering)

ENGINEERING SCIENCE

Course 5

The Engineering Science course is designed for students whose primary interest is in the applications of science to modern technology, and who wish to prepare themselves for careers in research, development or teaching. The undergraduate course provides excellent preparation for post-graduate work in a wide range of specialities in Engineering, Science and Mathematics, and the majority of graduates from this course do proceed to graduate study. Students who graduate from the course and do not continue their studies are nevertheless well qualified to fill a variety of positions in Industry and Government.

The courses offered are of a high standard, so that only students with better-than-average ability in mathematics and science can expect to succeed in them. For this reason, admission is granted only to those who attain an average of at least 70% in the Ontario Grade XIII or its equivalent (see p. 9). The First Year of the Course may not be repeated without the special permission of the Council of the Faculty, and

continuation into the second year is restricted to those whose weighted average grade in first year is 66% or higher. Those who achieve the general promotion average of 60% in the first year may continue without condition into the second year of any other course in the Faculty.

The curricula for the first two years of the course are common for all students. In the third and fourth years, there are a few common subjects, and considerable latitude in the selection of the remainder. There are available eight carefully planned *options*,† each of which provides a specialized preparation for a particular branch of applied science. In addition students have the opportunity not to enroll in any one of these options, but to take an *elective program*, as outlined below.

For the First Year curriculum see Division B, page 23.

SECOND YEAR ENGINEERING SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Calculus	2425	3	2	3	2
Economics	2720	2	—	2	—
Electric Circuits	715, 716	2	1½	2	1½
Mechanics of Materials	103	2	—	—	—
Numerical Methods	2429	3	2	—	—
Physical Chemistry	608, 609	2	1½	2	1½
Physics	2521, 2522	3	3	3	3
Probability and Statistics	2427	—	—	3	2

Each student is asked to indicate before the end of Second Year his intended course of study in the Third and Fourth Years, but such indication is not binding. He may elect to enroll in one of the options listed, or alternatively to select a program that does not conform to any one of them. In the latter case, there are three conditions to be met.

(i) The program shall average from 18 to 20 load units over the year. One unit is 1 hour lecture per week or 3 hours laboratory per week.

(ii) The selection of courses is subject to the constraints imposed by the current timetable of lectures and laboratories, and by prerequisites. Information about third year prerequisites for fourth year courses is available in the Engineering Science office.

(iii) The program must be discussed with, and approved by a member of the staff of the Division of Engineering Science.

† For further information about the Aerospace Option, see page 58.

THIRD YEAR ENGINEERING SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK First Term Lect.	First Term Lab.	Second Term Lect.	Second Term Lab.
COMMON SUBJECTS					
Differential Equations	2438	2	—	2	—
Theory of Functions	2437	2	—	2	—
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				
OPTION 5A, *Aerospace*					
Advanced Mechanics	1030	2	—	2	—
Atomic Structure and Quantum Physics	2533	—	—	4	—
Physical Electronics	739, 738	2	—	2	3
Mechanics of Structures	1034, 1035	2	1½	2	3
Fluid Mechanics	1028, 1029	2	3	1	1½
Physics Laboratory	2532	—	3	—	3
Statistical Physics	2531	2	—	—	—
OPTION 5C, *Chemical*					
Atomic & Molecular Structure	2631	2	—	2	—
Chem. Eng. Rate Processes	641	—	—	3	—
Chem. Eng. Thermodynamics	640	2	—	2	—
Chem. Eng. Problems & Lab	642	—	9	—	7½
Electronics	740, 741	2	—	2	1½
Fluid Mechanics	338	2	3	—	—
Synthetic Chemistry	626	2	—	2	—
OPTION 5CS, *Computer Science*					
Advanced Programming I	3338	3	6	—	—
Advanced Programming II	3339	—	—	3	6
Atomic Structure and Quantum Physics	2533	—	—	4	—
Circuit Analysis	742	2	—	2	—
Physical Electronics	739, 738	2	—	2	3
Statistical Physics	2531	2	—	—	—
OPTION 5E, *Electrical*					
Advanced Mechanics	1030	2	—	2	—
Atomic Structure and Quantum Physics	2533	—	—	4	—
Circuit Analysis	742	2	—	2	—
Electromagnetic Fields	754	1	1	1	1

THIRD YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Physical Electronics	739, 738	2	—	2	3
Physics Laboratory	2532	—	3	—	3
Physics of Solids and Fluids	2534	2	—	—	—
Statistical Physics	2531	2	—	—	—
OPTION 5G, *Geophysics*					
Advanced Mechanics	1030	2	—	2	—
Atomic Structure and Quantum Physics	2533	—	—	4	—
Electronics	740, 741	2	—	2	1½
Geophysics	2537	1	—	1	—
Physics Laboratory	2532	—	3	—	3
Physics of Solids and Fluids	2534	2	—	—	—
Principles of Geology	2920	2	2	2	2
Statistical Physics	2531	2	—	—	—
OPTION 5M, *Materials Science*					
Atomic and Molecular Structure	2631	2	—	2	—
Metallurgical Thermodynamics	830, 831	2	2	2	2
Physics of Metals	821, 822	2	6	2	3
Materials Science	838	—	—	2	—
Physics of Solids and Fluids	2534	2	—	—	—
X-ray Crystallography	2901	—	2	—	2
and *one* of					
Advanced Mechanics	1030	2	—	2	—
Physical Electronics	738, 739	2	—	2	3
Inorganic Chemistry	634	2	—	2	—
OPTION 5NT, *Nuclear and Thermal Power*					
Advanced Mechanics	1030	2	—	2	—
Experimental Stress Analysis	365, 366	2	—	1	3
Atomic Structure and Quantum Physics	2533	—	—	4	—
Fluid Mechanics	340	2	3	2	3
Heat Engineering	313, 314	1	3	1	3
Physics Laboratory	2532	—	3	—	3
Statistical Physics	2531	2	—	—	—
OPTION 5P, *Physics*					
Advanced Mechanics	1030	2	—	2	—

THIRD YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Atomic Structure and Quantum Physics	2533	—	—	4	—
Electromagnetic Fields	754	1	1	1	1
Physical Electronics	739, 738	2	—	2	3
Physics Laboratory	2532	—	3	—	3
Physics of Solids & Fluids	2534	2	—	—	—
Statistical Physics	2531	2	—	—	—
and one of:					
Experimental Stress Analysis	365, 366	2	—	1	3
Circuit Analysis	742	2	—	2	—
ADDITIONAL ELECTIVE					
Operational Research I	424	2	2	2	2

FOURTH YEAR ENGINEERING SCIENCE

COMMON SUBJECTS					
Differential Equations of Mathematical Physics	2445	2	—	2	—
Philosophy and Science	2040	2	—	—	—
English	2140	1	—	1	—
Thesis	40	—	—	—	—
OPTION 5A, *Aerospace*					
Aerodynamics	1040, 1041	2	1½	2	1½
Electronic Circuits	778, 769	2	—	1	3
Engineering Design	1047	—	6	—	3
Gasdynamics	1048, 1049	2	1½	2	3
Transport Phenomena	1050	—	—	2	—
And two of:					
Physics and Mechanics of Solids	1044, 1045	2	1½	2	3
Physics of Radiating Gases	1042, 1043	2	1½	2	1½
Plasmadynamics	1046	2	—	2	—
System Dynamics	766, 773	2	1½	2	1½
OPTION 5C, *Chemical*					
Chem. Eng. Design	666	2	6	2	6
Chem. Eng. Laboratory	652	—	9	—	—
Thermodynamics of Chemical Systems	665	3	—	—	—
Dynamics of Chemical Systems	667	—	—	3	—

FOURTH YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK First Term Lect.	First Term Lab.	Second Term Lect.	Second Term Lab.
Mass Transfer	650	2	—	2	—
Organic Chemistry	660, 661	2	—	1	6
Process Dynamics	664	2	—	2	3
OPTION 5CS, *Computer Science*					
Automata Theory	3340	2	—	2	—
Computer Organization	3341	—	—	2	2
Electronic Circuits	778, 769	2	—	1	3
Information Systems I	782	2	—	1	—
Numerical Solution of Partial Differential Equations	2440	2	—	2	—
Switching Theory	760	2	1	—	—
Techniques of Optimization	787	2	3	2	3
OPTION 5E, *Electrical*					
Energy Conversion Processes	788, 789	2	1½	2	1½
Electronic Circuits	778, 769	2	—	1	3
Information Systems I	782	2	—	1	—
Information Systems II	786, 783	—	—	2	3
Quantum Mechanics	2545	2	—	2	—
System Dynamics	766, 773	2	1½	2	1½
Wave Theory	790, 791	2	3	2	—
OPTION 5G, *Geophysics*					
Control Systems	398, 399	1	—	2	3
Geophysics Laboratory	2573	—	6	—	9
Geophysical Methods	2561	2	—	2	—
Physics of the Earth	2570	2	—	2	—
Geology	2903	2	2	2	2
And one of:					
Atmospheric Physics	2571	2	—	2	—
Tectonophysics	2574	2	—	2	—
OPTION 5M, *Materials Science*					
High Temperature Physical Chemistry	840	2	2	2	2
Physics of Metals	823	2	—	2	—
Materials Science	839	2	3	2	3
Theory of Metallurgical Reactions	841	2	—	—	—

FOURTH YEAR ENGINEERING SCIENCE (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Materials Science Laboratory	827	—	6	—	9
And one of:					
Solid State Physics	2546	—	—	4	—
Wave Mechanics, Statistical Thermodynamics & Kinetics	CHM-327	2	—	2	—
Quantum Mechanics	2545	2	—	2	—
OPTION 5NT, *Nuclear and Thermal Power*					
Control Systems	398, 399	1	—	2	3
Heat Transfer	328	—	—	2	—
Nuclear and High Energy Physics	2544	—	—	4	—
Nuclear Engineering	670, 671	2	3	2	3
Physics Laboratory	2542	—	3	—	3
Thermal Energy Conversion	331, 332	3	3	3	3
Computational Methods	393	1	3	1	3
OPTION 5P, *Physics*					
Electronic Circuits	778, 769	2	—	1	3
Physics Laboratory	2542	—	6	—	6
Quantum Mechanics	2545	2	—	2	—
Wave Theory	790	2	—	2	—
And any two of:					
Electromagnetic Radiation and Matter	2541	2	—	2	—
Molecular Physics and Statistical Mechanics	2543	4	—	—	—
Nuclear and High Energy Physics	2544	—	—	4	—
Relativity Theory	2547	4	—	—	—
Solid State Physics	2546	—	—	4	—

ADDITIONAL ELECTIVES

Human Factors Engineering and Equipment Design	425	2	—	—	—
Man as a Machine	427	—	—	2	—
Operational Research II	419	3	3	3	3
Information Processing Systems I	761	2	1	—	—
Information Processing Systems II	798	—	—	2	1

Chemical Engineering and Applied Chemistry

STAFF OF THE DEPARTMENT

Professor and Head of the Department:

J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.)

Associate Professor and Assistant Head of the Department:

J. W. Smith, M.A.SC.(U.B.C.), PH.D.(LOND.)

Professors:

D. G. Andrews, M.A.(CANTAB.) (*Nuclear Engineering*)
W. H. Burgess, B.CH.E., M.F.S., PH.D.(CORN.)
W. F. Graydon, M.A.SC., PH.D.(MINN.)
R. E. Jervis, M.A., PH.D.
W. G. MacElhinney, M.A.SC.
R. W. Missen, M.SC.(QU.), PH.D.(CANTAB.)
W. H. Rapson, M.A.SC., PH.D.
I. H. Spinner, M.A.SC., PH.D.
O. Trass, B.S.E.(PRINC.), SC.D.(M.I.T.)
M. Wayman, M.A., PH.D.
H. L. Williams, B.A., M.SC.(WESTERN), PH.D.(MCGILL)

Associate Professors:

D. Basmadjian, DIP. ING. CHEM.(ZURICH), M.A.SC., PH.D.
M. E. Charles, B.SC.(LOND.), M.SC., PH.D.(ALTA.)
W. A. M. Hewer, B.A.SC. (*Mining Engineering*)
R. L. Hummel, B.S.(PURDUE), PH.D.(IOWA)
R. F. Hunter, M.A.SC., PH.D.
R. Luus, M.A.SC., A.M., PH.D. (PRINCETON)
M. R. Piggott, M.SC., PH.D.(LOND.) (*Materials Science*)
S. Sandler, M.A.SC.
R. T. Woodhams, M.SC.(U.W.O.), PH.D.(BROOKLYN) (*Materials Science*)

Assistant Professors:
D. Barham, B.SC.ENG., D.I.C., PH.D.(LOND.)
C. E. Chaffey, B.SC., PH.D.(MCGILL) (*Materials Science*)
D. Mackay, B.SC., PH.D. (GLASGOW)
C. R. Phillips, B.E., PH.D.(ADELAIDE)
P. Y-C. Wang, B.SC., PH.D.(MCGILL) (*Biomedical Electronics*)

Lecturers:
C. C. Barnes, B.SC.(QU.)
J. Binkiewicz, DIP. CHEM. ENG.(LWOW)
Z. May, DIP. ING. CHEM.(WARSAW)
Miss M. J. Phillips, B.A.SC., M.A.(BRYN MAWR), PH.D.(J.H.U.)
A. Rozeiu, DIP. CHEM. ENG.(BUCHAREST)

Special Lecturer:
C. P. Brockett, B.SC.(M.I.T.)

CHEMICAL ENGINEERING

Course 6

The chemical engineer is concerned with the development and operation of processes by means of which matter is chemically altered to a more useful form, and in the design, construction, operation and management of plant in which to effect such changes. In addition to such obviously chemical processes as those encountered in the petroleum refining and petro-chemical industry, a great variety of industrial processes involve chemistry and require the abilities of the chemical engineer. In order to equip a student to start his professional career as a chemical engineer, the undergraduate course is intended to provide him with training in the principles of the major divisions of chemistry and chemical engineering, together with the essentials of other engineering subjects.

In the second term of the final year, certain elective subjects and the topic chosen for the thesis allow the student to specialize according to his interests and abilities. The thesis serves as an introduction to research, and its nature may vary widely depending on the interests of the staff and students. It may, for example, be concerned with an experimental laboratory investigation, the design of a process, or a computer study of a chemical system.

For the First Year curriculum see Division A, page 22.

SECOND YEAR CHEMICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Analytical Chemistry	615, 614	2	9	—	—
Analytical Chemistry and Computation Laboratory	613	—	—	—	—
Calculus	2420	2	1	2	1
Chemical Engineering Science Laboratory	619	—	—	—	7½
Economics	2720	2	—	2	—
Electrical Engineering	719, 720	2	3	2	3
Introduction to Mass and Heat Transfer	631	2	—	2	—
Inorganic Chemistry	617	1	—	2	—
Mechanics of Materials	102	2	—	2	—
Physical Chemistry	622	2	—	2	—
Process Calculations	620	—	3	—	3
Practical Experience	20	—	—	—	—

THIRD YEAR CHEMICAL ENGINEERING

Applied Mathematics	633	1	1	1	1
Chemical Engineering Thermodynamics	640	2	2	2	2
Chemical Laboratory	627	—	6	—	6
Reaction Kinetics	625	1	—	1	—
Fluid Mechanics	339, 632	2	3	2	—
Industrial Chemistry	630	2	—	1	—
Mass Transfer Operations	650	2	1	2	1
Organic Chemistry	628, 629	2	6	2	9
Practical Experience	20	—	—	—	1
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR CHEMICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK			
		First Term		*Second Term*	
		Lect.	*Lab.*	*Lect.*	*Lab.*
Chemical Engineering Thermodynamics and Kinetics	655	2	—	2	—
Chemical Engineering Laboratory	652	—	9	—	—
Chemical Plant Design	651	2	6	—	—
English	2140	1	—	1	—
Organic Chemistry	654	2	—	2	—
Philosophy and Science	2040	2	—	—	—
Practical Experience	20	—	—	—	—
Process Dynamics	653	2	3	—	—
Public Speaking	656	—	—	—	2
Thesis	40	—	1	—	18
And one of:					
Advanced Separation Processes	669	—	—	2	—
Applied Nuclear Chemistry	668				
Instrumental Methods	663				
Process Control	662				

Electrical Engineering

STAFF OF THE DEPARTMENT

Professor and Head of the Department:
G. R. Slemon, M.A.SC., D.I.C.(IMP. COLL.), PH.D.(LOND.), D.SC.(LOND.)

Associate Professor and Assistant Head of the Department:
W. Janischewskyj, B.A.SC., M.A.SC.

Professors:
P. P. Biringer, DIP. ING.(BUD.), M.SC.(STOCKHOLM), PH.D.
J. M. Ham, B.A.SC., S.M.(M.I.T.), SC.D.(M.I.T.)
N. F. Moody, B.SC.(SASK.)
J. G. Simmons, B.SC.(LOND.), M.SC.(TEMPLE), PH.D.(LOND.), F.INST.P.
G. Sinclair, B.SC.(ALTA.), M.SC.(ALTA.), PH.D.(OHIO STATE)
J. L. Yen, B.SC.(CHIAO TUNG), M.A.SC., PH.D.

Visiting Professor:
J. A. Roberts, B.SC.(SYDNEY), M.SC.(SYDNEY), PH.D. (CAMBRIDGE)

Associate Professors:
K. G. Balmain, B.A.SC., M.S.(ILL.), PH.D.(ILL.)
P. E. Burke, B.E.(N.S. TECH.), M.A.SC.
R. S. C. Cobbold, B.SC.(LOND.), M.SC.(SASK.), PH.D.(SASK.)
E. J. Davison, A.R.C.T., B.A.SC., M.A., PH.D.(CANTAB.)
S. Dmitrevsky, B.A.SC., PH.D.(HARV.)
V. L. Henderson, B.A.SC., A.M.(MICH.)
K. Iizuka, B.S.(KYOTO), M.E.(KYOTO), M.S.(HARV.), PH.D. (HARV.)
A. J. Kravetz, B.SC.(ALTA.), M.A.SC.
G. R. Lang, B.SC.(U.W.O.)
E. S. Lee, B.ENG.(MCG.), M.ENG.(MCG.), PH.D.
E. Llewellyn Thomas, B.SC.(LOND.), M.D., C.M.(MCG.)
I. McCausland, B.SC.(Q.U. BELFAST), M.SC.(Q.U. BELFAST), PH.D.(TOR., CANTAB.)
S. D. T. Robertson, B.SC.(QUEEN'S), D.I.C.(IMP. COLL.), M.A.SC., PH.D.
H. W. Smith, B.A.SC., SC.D.(M.I.T.)

K. C. Smith, B.A.SC., M.A.SC., PH.D.
A. Straughen, B.SC.(LOND.), M.A.SC.

Assistant Professors:
R. T. H. Alden, B.A.SC., M.A.SC., PH.D.
P. I. P. Boulton, M.A.SC., D.I.C.(IMP. COLL.), PH.D.
M. G. Currie, B.A.SC.
I. R. Dalton, B.A.SC., M.S.(NORTHWEST)
S. B. Dewan, B.SC.(PUNJAB), M.E.(ROORKEE), M.A.SC., PH.D.
V. C. Hamacher, B.A.SC.(WATERLOO), M.SC.(QUEEN'S), PH.D.(SYR.)
H. Kunov, M.SC.(DENMARK)
H. O'Beirne, B.A.(CAMB.), M.A.SC.
V. M. Ristic, DIP. ING.(BELGRADE), M.SC.(BELGRADE), M.SC.(STAN.), PH.D.(STAN.)
I. H. Rowe, B.A.SC., M.A.SC., D.I.C.(IMP. COLL.), PH.D.(LOND.)
C. A. T. Salama, B.A.SC.(UBC), M.A.SC.(UBC), PH.D.(UBC)
M. Sablatash, B.SC.(MAN.), M.SC.(MAN.), PH.D.(WIS.)
R. S. Segsworth, B.A.SC.
Z. G. Vranesic, B.A.SC., M.A.SC., PH.D.
S. Zukotynski, M.A.SC.(WARSAW), PH.D.(WARSAW)

Lecturers:
L. D. Braun, B.A.SC., M.A.SC., PH.D.
M. G. Joy, B.A.SC., M.A.SC.
A. N. Venetsanopoulos, B.E.(ATHENS), M.A.SC.(YALE), PHIL.M.(YALE)

Special Lecturers:
M. A. Albisser, M.A.SC., PH.D.
D. J. Shepley, M.D., B.A.SC.

ELECTRICAL ENGINEERING

Course 7

Electrical Engineers are concerned with all things electrical; but such a simple statement fails to convey any real notion of the great variety of activity in which they are engaged, the many aspects of their concern, or the nature of the education that they require.

Electrical engineers are, of course, still involved in the application of new knowledge to the basic areas — the generation, transmission and utilization of electrical power and the communication of information —but they are being faced daily with situations not envisaged even a few years ago. They are searching continuously for new approaches that may be better suited to future needs, as for example, magneto-hydrodynamic generation, microelectronics and satellite communication. There is a growing demand for sophisticated electrical sensing and control equipment for a wide variety of non-electrical processes, and for electronic computers capable of the rapid

processing of large volumes of information and the solving of increasingly complex problems.

Within any of these areas the electrical engineer may be engaged in research, development, design, manufacture, operation or management. He may have to assist other engineers and scientists in widely differing fields by supplying them with techniques or insights unfamiliar to them, as for example, in the developing field of bio-medical engineering, or he may have to coordinate the application of many technologies in a single project. In addition to all of this, he must accept considerable responsibility in community affairs.

It is obvious then, from the wide range of his possible involvement, that the electrical engineer needs a professional education of great breadth and depth. In the undergraduate course, stress is laid on building a solid foundation. The time limitation requires that only material which is essential can be included; much that might be immediately helpful must be omitted to make room for that which will still be relevant for several years. On this base, the graduate will have to build his continuing education.

The electrical engineer makes extensive use of mathematical techniques and concepts; mathematics is thus of the utmost importance and a large portion of the course is devoted to it. Fundamental subjects such as mechanics, electrical physics, chemistry and thermodynamics get considerable attention in the early years. The basic electrical engineering subjects (electromagnetic field theory, electronics, machine principles and circuit theory) follow these, with expansion and some specialization in the final year. Also included are a few non-technical subjects of importance. In the final year, only one-third of the curriculum is prescribed by the department; students freely select the rest of their curriculum from a wide range of elective subjects.

Electrical engineering is characterized by the relatively large proportion of its graduates who proceed to post-graduate study to get advanced training in a particular area. Information on this may be obtained from the calendar and other publications of the School of Graduate Studies.

For the First Year curriculum see Division A, page 22.

SECOND YEAR ELECTRICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* *Lect.*	*First Term* *Lab.*	*Second Term* *Lect.*	*Second Term* *Lab.*
Calculus II	2421	4	2	—	—
Circuit Theory I	710	2	2	—	—
Material Science I	819	3	1½	—	—
Electrical Laboratory	713	—	3	—	—
Dynamics	352, 353	3	2	—	—
Numerical Methods	721	—	—	2	2

SECOND YEAR ELECTRICAL ENGINEERING (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Circuit Theory II	712	—	—	3	2
Thermodynamics & Statistical Mechanics	751	—	—	3	1
Introductory Electronics	714	—	—	2	3
Electric & Magnetic Fields	711	—	—	3	2
Economics	2720	2	—	2	—
Practical Experience	20	—	—	—	—

THIRD YEAR ELECTRICAL ENGINEERING

Applied Mathematics I	732	2	2	—	—
Linear Systems Theory	733	4	2	—	—
Physical Electronics I	730	2	1½	—	—
Fields & Waves	750	2	2	—	—
Electromechanical Systems I	734	2	3	—	—
Applied Mathematics II	736	—	—	3	2
Material Science II	835	—	—	2	1½
Physical Electronics II	731	—	—	2	1½
Electronic Circuits I	737	—	—	2	3
Electromechanical Systems II	735	—	—	2	3
Thermodynamics & Statistical Mechanics	751	—	—	3	1
Practical Experience	20	—	—	—	—
One of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR ELECTRICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.	*Prerequisite*
Control Systems I	765	3	1½	—	—	
Electronic Circuits II	768	2	3	—	—	
Philosophy & Science	2040	2	—	—	—	
English	2140	1	—	1	—	

FOURTH YEAR ELECTRICAL ENGINEERING (CONTINUED)

SUBJECTS	SUBJECT NO.	HOURS PER WEEK First Term Lect.	First Term Lab.	Second Term Lect.	Second Term Lab.	Prerequisite
Engineering Law	3440	1	—	—	—	
Thesis	40	—	—	—	—	
Practical Experience	20	—	—	—	—	
ELECTIVES[1]						
3 to be chosen first term[5]						
Applied Mathematics III	781	2	1	—	—	
Electromagnetic Theory	762	2	1	—	—	
Information Processing Systems I	761	2	1	—	—	
Network Theory	772	2	1	—	—	
Power Systems Analysis	779	2	1½	—	—	
Quantum Physics	777	2	1½	—	—	
Solid State Physics for Engineers	775	2	1½	—	—	
Switching Theory	760	2	1	—	—	
Other Technical Elective[3]		2	1½[4]	—	—	
5 to be chosen second term[5]						
Illumination	7942 } 2	—	—	2	1½	
Quantum Electronics	7842 } 2	—	—	2	1	777
Power System Control	7802 } 2	—	—	2	1½	
Radiation & Propagation	7762 } 2	—	—	2	1½	762
Acoustics	792	—	—	2	1½	
Biomedical Engineering	796	—	—	2	1½	
Communication Systems	770	—	—	2	3	
Control Systems II	793	—	—	2	1	
Electrodynamics	797	—	—	2	1	762
Information Processing Systems II	798	—	—	2	1	761
Integrated Circuits	774	—	—	2	1½	
Power Semiconductor Circuits	795	—	—	2	1½	
Unified Machine Theory	763	—	—	2	1½	
Switching Circuits	799	—	—	2	1½	
Other Technical Elective[3]		—	—	2	1½[4]	

(1) For grading purposes all electives are of equal weight.
(2) Paired courses will be timetabled concurrently.
(3) Arranged with the permission of the head of the department.
(4) Lab time is shown as a guide only.
(5) Additional courses may be selected with the permission of the head of the department.

Metallurgy and Materials Science

STAFF OF THE DEPARTMENT

Professor and Chairman of the Department:
C. B. Alcock, B.SC., PH.D.(IMP. COLL.)

Professors:
K. T. Aust, M.A.SC., PH.D.
G. B. Craig, M.A.SC., PH.D.
S. N. Flengas, B.SC.(ATHENS), D.I.C.(LOND.), PH.D., D.SC.(LOND.), F.C.I.C.
H. U. Ross, C.D., M.SC.(MCG.)
J. W. Rutter, M.A., PH.D.

Associate Professors:
Mrs. U. Martius Franklin, PH.D.(BERLIN)
B. Ramaswami, B.SC., D.I.I.SC., M.A., PH.D.(HARVARD)
J. M. Toguri, M.A.SC., PH.D.

Assistant Professors:
W. A. Miller, PH.D.(MCG.)
R. S. Segsworth, B.A.SC.
G. C. Weatherly, PH.D.(CANTAB.)

METALLURGY AND MATERIALS SCIENCE

Course 8

"Metallurgy and Materials Science" is the study of the production, structure, and properties of the engineering materials used in structures, machines and devices.

Modern technology makes increasingly severe demands upon both metallic and non-metallic solids; in fact, it is difficult to think of an engineering project, the basic limitations of which do not reside in the materials which are available. For example, aerospace travel requires materials capable of withstanding extremes of heat, cold and pressure; the utilization of nuclear energy is limited only by materials which can withstand the effects of radiation; the transistor and the computer depend upon mate-

rials having special electrical and magnetic properties. As industry expands, the metallurgist or materials engineer is being called upon to play an increasingly important role in the economy.

The course is designed to place primary emphasis upon the fundamental principles which underlie the chemical, physical and mechanical properties of solids. In the fourth year, each student is assigned an experimental problem involving original work and, where possible, this is related to the actual research in progress in the department. The student is, therefore, introduced to the methods of research.

The department is equipped with modern facilities for the study of the structure and properties of materials. This equipment includes x-ray diffraction units, an electron beam microprobe analyzer, an electron microscope, several optical metallographs, materials preparation and testing equipment, facilities for the production and measurement of high temperatures, high vacuum equipment, etc.

For the First Year curriculum see Division A, page 22.

SECOND YEAR METALLURGY AND MATERIALS SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Calculus	2420	2	1	2	1
Economics	2720	2	—	2	—
Electrical Engineering	719, 720	2	3	2	3
Inorganic Chemistry	617	1	—	2	—
Materials Science	832	2	—	2	—
Mechanics of Materials	106, 104	2	—	1	1½
Physical Chemistry	801	2	2	2	2
Principles of Metallography	816	1	3	—	—
Probability and Statistics	2423	2	2	2	2
Practical Experience	20	—	—	—	—
Metallurgical Analysis	808	—	—	—	3

THIRD YEAR METALLURGY AND MATERIALS SCIENCE

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Chemical Metallurgy	802, 803	—	3	2	6
Differential Equations	2432	2	1½	2	1½
Fluid Flow and Heat Transfer	341	2	—	2	3
Materials Processing	833	3	—	—	—
Physics of Metals	821, 822	2	6	2	3
Thermodynamics in Metallurgy	810, 812	2	4	2	4
X-ray Crystallography	2901	—	2	—	2
Practical Experience	20	—	—	—	—
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

FOURTH YEAR METALLURGY AND MATERIALS SCIENCE

Chemical Metallurgy	805, 806	2	6	2	—
English	2140	1	—	1	—
Materials Science Seminar	826	—	3	—	3
Metallurgical Problems Laboratory	814	—	4	—	4
Philosophy and Science	2040	2	—	—	—
Physics of Metals	823, 824	2	3	2	3
Reaction Kinetics	836	2	2	—	—
Thesis	40	—	6	—	9
Practical Experience	20	—	—	—	—
Materials Science	815	2	—	2	—
Instrumental Methods	663	—	—	2	—
Electrochemical Processes	813	—	—	2	2

Geological Engineering

The course in Geological Engineering is an interfaculty course, the specialized core of which is provided by the Department of Geology (Faculty of Arts and Science) with assistance from several departments of the Faculty of Applied Science and Engineering. It is administered by a Course Committee the current members of which are:

E. W. Nuffield, B.A.(B.C.), PH.D., F.R.C.S., *Chairman; Professor and Chairman, Department of Geology.*

W. D. Baines, B.SC.(ALTA), M.SC., PH.D.(IOWA); *Professor of Mechanical Engineering.*

J. G. Breckenridge, B.A.SC., PH.D.(CANTAB.), *Professor and Head, Department of Chemical Engineering.*

J. B. Currie, B.A.(MCM.), M.A., PH.D., *Professor of Geology.*

T. C. Kenney, B.ENG.(MCG.), D.I.C.(IMP.), M.SC.(LOND.), PH.D.(LOND.), *Professor and Chairman, Department of Civil Engineering.*

H. R. Rice, B.SC.(QUEEN'S), *Professor of Mining Engineering.*

GEOLOGICAL ENGINEERING

Course 9

Geology is the science of the earth. It includes, in a large sense, all knowledge of the earth – its origin, history, structure, composition and mineral wealth – and the physical, chemical and biological processes that change the earth. It spans a wide range of sciences and requires a thorough grounding in mathematics and the basic science and engineering disciplines to aid in a proper understanding of the subject and its many applications. The various branches of geology include geophysics, which is concerned with the investigation of the earth, particularly its structure and composition, by the methods of experimental physics; geochemistry, which may be defined broadly to include all parts of geology that involve chemical changes; and geobiology which deals with the totality of living things on the earth's surface in geologic time.

The first three years of the course in Geological Engineering provide a broad education in the fundamentals of geology and its associated disciplines. In the fourth year the course concentrates on the study of Economic Geology – the application of principles and methods of geology in the discovery, examination, evaluation and production of mineral, fossil fuel and water resources. An option in the last year allows the student to choose between the subjects Exploration Geophysics (2568, 2569) and Mine Operation and Administration (224, 226) thereby emphasizing either the search for or the development of mineral deposits.

Graduation from this course leads to employment in mineral and petroleum exploration and development. Graduates are prepared for advanced study towards the M.A.Sc. and Ph.D. degrees in a number of branches of geology including Economic Geology, Geochemistry, Structural Geology and Applied Geophysics.

For the First Year curriculum see Division A, page 22.

SECOND YEAR GEOLOGICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK *First Term* Lect.	*First Term* Lab.	*Second Term* Lect.	*Second Term* Lab.
Calculus	2420	2	1	2	1
Economics	2720	2	—	2	—
Geological Data Processing by Computer	2922	1	2	1	2
Inorganic Chemistry	617	1	—	2	—
Mineralogy	2921	2	4	2	4
Mining	195	1	—	1	2
Principles of Geology	2920	2	3	2	3
Surveying	155, 156	1	1½	1	1½
Practical Experience	20	—	—	—	—

THIRD YEAR GEOLOGICAL ENGINEERING

SUBJECTS	SUBJECT NO.	HOURS PER WEEK First Term Lect.	First Term Lab.	Second Term Lect.	Second Term Lab.
Geological Field Trips	2937	—	—	—	—
Mechanics of Materials†	104, 106	2	—	1	1½
Extractive Metallurgy	804	2	—	2	—
Mineral Identification Laboratory	2934	—	2	—	2
Petrology	2930	2	2	2	2
Physical Geochemistry	2935	3	—	3	—
Practical Experience	20	—	—	—	—
Stratigraphy and Sedimentation	2931	2	2	2	2
Tectonics	2932	1	3	1	3
Survey Camp	158	—	—	—	—
One of:					
*Differential Equations	2432	2	1½	2	1½
Mining Technology	196	2	—	2	—
And one of:					
History	2330 *or* 2332	2	—	2	—
Political Science	2730				

*Prerequisite for Exploration Geophysics 2568, 2569 in the Fourth Year.
†Commencing in the session 1970–71.

FOURTH YEAR GEOLOGICAL ENGINEERING

English Literature	2140	1	—	1	—
Exploration Geochemistry	2943	1	3	1	3
Geological Field Trips	2947	—	—	—	—
*Geology Field Camp	2946	—	—	—	—
Mineral Deposits	2940	2	3	2	3
Mineral Economics	2944	2	—	1	3
Petroleum and Groundwater Geology	2941	2	3	2	3
Philosophy and Science	2040	2	—	—	—
Thesis	40	—	3	—	3
And one of:					
Exploration Geophysics	2568, 2569	2	3	2	3
Mining	197, 198	2	3	2	3

*Immediately following the Annual Examinations of the Third Year.

Aerospace Studies

TEACHING STAFF OF THE INSTITUTE FOR AEROSPACE STUDIES

Professor and Director of the Institute:

G. N. Patterson, B.SC.(ALTA.), M.A., PH.D., LL.D., D.SC., F.R.AE.S., F.C.A.S.I., F.A.I.A.A., F.R.S.C., F.A.A.A.S.

Professors and Assistant Directors:

J. H. deLeew, DIP. ING.(DELFT), M.S. in A.E.(GEORGIA TECH.), PH.D., F.C.A.S.I. (*Assistant Director – Research.*)

I. I. Glass, B.A.SC., M.A.SC., PH.D., F.A.P.S., F.A.A.A.S., F.C.A.S.I. (*Assistant Director – Education*).

Professors:

B. Etkin, B.A.SC., M.A.SC., F.C.A.S.I.

J. B. French, B.A.SC., M.SC.(BIRMINGHAM), PH.D.

H. S. Ribner, B.S.(CAL. TECH.), M.S.(WASH.). PH.D.(WASH.), F.A.P.S., F.A.S.A., F.C.A.S.I.

Associate Professors:

A. J. Howsmon, B.S.M.E. (PURDUE), M.S.(PURDUE), PH.D.(PURDUE)

G. K. Korbacher, DIP. ING.(BERLIN), PH.D.(BRAUNSCHWEIG)

R. C. Tennyson, B.A.SC., M.A.SC., PH.D.

S. J. Townsend, B.A.(SASK.), M.A.(SASK.), PH.D.

Assistant Professors:

P. C. Hughes, B.A.SC., M.A.SC., PH.D.

J. W. Locke, B.A.SC., M.A.SC.

R. M. Measures, B.SC., A.R.C.S., D.I.C., PH.D.(LOND.)

L. D. Reid, B.A.SC., M.A.SC.

P. A. Sullivan, B.E., M.E.(N.S.W.), D.I.C., PH.D.(LOND.)

AEROSPACE STUDIES

A five-year program of study is offered to prepare the student for a career in the aerospace field. It includes the following elements: (*a*) an introduction to the fundamentals of mathematics, physics, and chemistry, (*b*) an introduction to aerodynamics,

instrumentation, propulsion, structures and design, and (*c*) an advanced treatment of the subjects required for modern design and research in aerospace science and engineering such as hypersonic aerodynamics, flight dynamics, and space propulsion. Under (*a*) and (*b*) the student's training is necessarily broad and basic. The more advanced knowledge needed for the research, development, and design relevant to new aircraft and spacecraft is provided under (*c*) and is of particular significance. Parts (*a*) and (*b*) are provided in a four-year undergraduate course, but the final intensive training under (*c*) is left for a postgraduate (fifth) year.

The program of study that leads to status as a well-qualified aerospace engineer has been established in two parts as follows:

(i) *Undergraduate Course.* The student registers in the course in Engineering Science, subject to the entrance requirements given on page 9 of this Calendar. This course provides the requisite training in the fundamental sciences (see (*a*) above). The advanced subjects contained in the Aerospace option given in the third and fourth years are taught by the staff of the Institute for Aerospace Studies (see (*b*) above). The student will receive the degree of Bachelor of Applied Science upon completion of this part of the program.

(ii) *Graduate Course.* If the student's academic record in the undergraduate program meets the requirements for admission to the School of Graduate Studies, he may enter the fifth year of the program as a candidate for the M.A.Sc. or M.Eng. degree in the (graduate) department of Aerospace Studies. Details of entrance regulations and courses of study are given in the Calendar of the School of Graduate Studies. The facilities of the Institute for Aerospace Studies are available to the student for research or project work. For details of research projects, assistantships, scholarships and demonstratorships, students should consult the Annual Bulletin of the Institute.

It should be noted that a student who has graduated in another branch of engineering and who desires to qualify as an aerospace engineer may proceed directly with (ii) above, but in this case the course leading to the M.A.Sc. or M.Eng. degree must be arranged so that deficiencies in his undergraduate training are made up.

The facilities of the Institute are available for further graduate study leading to the Ph.D. Degree.

Outline of Lecture and Laboratory Subjects

On the pages that follow a brief description is given of the lectures and laboratory subjects prescribed in the preceding tables of curriculum. The numbers before the subjects are the reference numbers assigned in the tables; the line following each subject title shows the academic year and course to which the subject is offered and the hours allotted to it in each term.

Where laboratory reports are to be written outside of assigned laboratory hours the maximum number of such reports is indicated in the description of the laboratory course concerned.

11s. ENGINEERING SEMINARS

I – 1, 3, 4, 5, 6, 7, 8, 9 – ½ – ½

A discussion of topics such as: the solution of practical engineering problems; problems arising from courses taken in the First Year; the prosecution of engineering research; or any other topic connected with the student's activities in the University.

The Professorial Staff in Engineering

13s. MATHEMATICAL APPLICATIONS AND COMPUTER PROGRAMMING

I – 1, 3, 4, 6, 7, 8, 9 ½ 2 ½ 2

Problems will be assigned to illustrate engineering applications of mathematics. Many of the solutions will apply first-year mathematics to solve problems in Applied Mechanics, Chemistry or Electricity. The concepts of algorithms, stored programs and computer coding will be introduced; some of the more time-consuming numerical and non-numerical applications will be solved with the aid of a computer.

The Staff in Engineering

20. PRACTICAL EXPERIENCE

Students in the courses listed below are required to have, before graduation, practical work of a nature acceptable to the department concerned. This may be obtained during the summer vacations but work done before entering the Faculty may also meet the requirements. Instructions will be issued by the departments concerning the

type of work which is acceptable. Practical experience certificate forms may be obtained from the departments and should be returned there when completed.

Course 1	600 hours	Course 7	600 hours
Course 3	600 hours	Course 8	600 hours
Course 4	600 hours	Course 9	600 hours
Course 6	600 hours		

40. THESIS

Every student in the Fourth Year is required to prepare a thesis on an approved subject. Instruction will be issued by the department concerned.

In some cases written presentation is required, in other oral and written, or it may consist of a research problem followed by a written thesis or report

DEPARTMENT OF CIVIL ENGINEERING

100s. APPLIED MECHANICS

I – 1, 3, 4, 6, 7, 8, 9 — 2 ¾ 2 ¾

Statics: The principles of statics are applied to the composition and resolution of forces, moments and couples. The equilibrium states of frames and machines are examined. The distributed load concept is applied to finding centroids, centers of mass and fluid pressure. The method of virtual work is applied to systems of rigid bodies and elastic members. Dynamics: Applications of the principles of dynamics are discussed for motion on straight and curved paths. Work, energy, power and momentum concepts are applied to particles, systems of particles and rigid bodies. Simpler applications in relative motion are considered. Throughout statics and dynamics the free body concept is emphasized and vector algebra is used where it is most useful. Textbook: *Engineering Mechanics; Statics and Dynamics* – Huang.

Staff in Civil and Mechanical Engineering

101. STATICS

I – 5 — 2 – – –

Translational and rotational resultants and equilibrants are discussed together with equivalent force systems in two- and three-dimensional space. Emphasis is placed on systems in equilibrium. Distributed forces, applications to structures, friction, method of virtual work, potential energy and stability of equilibrium considered. Textbook: *Engineering Mechanics; Statics* – Huang.

102. MECHANICS OF MATERIALS

II– 4, 6 — 2 – 2 –

In this subject, the fundamental theories of stress and strain are investigated as they apply to the selection of adequately proportioned materials to carry a given load in

such engineering applications as tension, compression torsional, and other members. Textbook: *Engineering Mechanics of Deformable Bodies* – Byars and Snyder.

103. MECHANICS OF MATERIALS

II – 5 2 – – –

Basis relationships between force, stress, strain, and deflection of bodies made of various engineering materials are discussed. Beams, columns, shafts, tension members and pressure vessels are analysed and designed for strength and stiffness. Textbook: *Mechanics of Materials* – Popov.

104. MECHANICS OF MATERIALS LABORATORY

II – 3 – – – 3
II – 4 – 3 – –
II – 8 – – – 1½

An introduction to testing machines, strain and other measuring devices and standard specifications. The experimental study of some engineering materials and structural members under applied load. No laboratory reports will be required to be written outside the assigned teaching hours.

106. MECHANICS OF MATERIALS

II – 8 2 – 1 –

The fundamental relations among stress, strain and applied load are worked out for tension, compression, twisting and bending in the elastic and inelastic ranges, for various engineering materials. Buckling phenomena are examined for struts and columns. Numerical applications are done in lectures; and problems are assigned for study. Textbook: *Engineering Mechanics of Deformable Bodies* – Byars and Snyder.

107. MECHANICS OF MATERIALS

II – 3 3 – 1 –

In this subject the following are examined: behavior of materials under applied loading or deformation; stress-strain relations; simple tension, compression torsion, bending and buckling of engineering components; mechanical properties of materials such as ductility, yielding, fracture; fluctuating stresses, stress concentration and fatigue. Mohr's circle will be used in certain stress and certain strain relationships. Textbook: *Engineering Mechanics of Deformable Bodies* – Byars and Snyder.

108. ENGINEERING MECHANICS

II – 1 – – 2 –

Topics to be considered include rigid body dynamics, energy principles applied to statics problems, virtual work, strain energy and an introduction to vibration.

109s. ENGINEERING MATERIALS

II – 1 2– 2 3

Mechanical properties of materials on atomic as well as macroscopic levels. The topics covered include atomic bonding, structure of crystals, phase transformations and diffusion, mechanical properties of materials and corrosion phenomena. Thermodynamics of adsorptions, freezing mechanisms in porous materials, surface phenomena, colloidal suspensions, gels and pastes, concrete, wood, bituminous materials, polymers, composite materials and the selection of materials for specific applications. The laboratory program deals with materials on a macroscopic level.

110. STRENGTH OF MATERIALS

II – 1 3 – – –

An introduction to the elastic and inelastic behaviour of solids under various load conditions. Stress, strain and deformation relations are determined for members loaded axially, in torsion, in bending and compression.

111. DESIGN OF STRUCTURES

II – 1 – – 2 2

III – 1 2 2 – –

In this subject the total design process involved in achieving any final structure will be introduced. The application of these procedures to determinate structural systems will be presented through the design of several such structures. The principal engineering materials, reinforced concrete, steel, and timber will be treated.

112. DESIGN OF DETERMINATE AND INDETERMINATE STRUCTURES

III – 1 2 2 3 2

A continuation of the subject Design of Structures with emphasis on more complex determinate systems.

The analysis of simple indeterminate structural systems is examined. At the same time, design aspects of these systems in reinforced concrete and in steel will be considered.

113. ENGINEERING MATERIALS

III – 1 2 – – –

An applied materials course dealing with concrete, steel, timber, masonry and other materials of construction.

116. REINFORCED CONCRETE I

IV – 1A, 1C 2 3 2 3

Ultimate and working strength behaviour of reinforced concrete members subjected to flexure, axial compression, shear, combined axial compression and flexure, combined flexure and shear, and bond. Relation between research results and current

specifications for design of members. Design of simple and continuous beams, one way, two way and flat slabs, columns, retaining walls and footings. Reference books: *Reinforced Concrete Fundamentals* – Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Nilson.

117. REINFORCED CONCRETE II

IV – 1A, 1C (elective) – – 3 2

Ultimate design; prestressed concrete; composite design; design of building frames, arches and bridges. Behaviour of reinforced concrete members. Reference books: *Theory & Practice of Reinforced Concrete* – Dunham. *Reinforced Concrete Design* – Sutherland and Reese. *Reinforced Concrete Fundamentals* – Ferguson. *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Nilson.

118. BEHAVIOUR AND DESIGN OF STEEL STRUCTURES

IV – 1A 2 2 2 2

The behaviour of structural elements and structures is discussed and related to design methods and criteria. Topics include, repeated loading, brittle fracture, welding, connections, buckling, inelastic behaviour, analysis and design of metal structures by ultimate load procedures. Textbooks: *Structural Steel Design* – Beedle *et al. Canadian Institute of Steel Construction* – Steel Construction Series, Books 1, 2, 3.

119. STRUCTURAL THEORY II

IV – 1A 2 2 3 2

Analysis of statically indeterminate structures; influence lines for statically indeterminate structures; the use of strain energy, slope deflection, moment distribution, column analogy and Kani methods for the analysis of frameworks; elementary aspects of matrix formulation of the analysis of statically determinate and indeterminate plane structures; an introduction to plate theory.

120. THESIS PROJECT AND MECHANICS OF MATERIALS LABORATORY

IV – 1A – 4 – 4

Project and Mechanics of Materials laboratory to supplement courses 116 and 118.

122. STRUCTURAL ENGINEERING II

IV – 1B 2 4½ 2 3

Cements and concrete; design and analysis of reinforced concrete members. Design and analysis problems. In the first term 3 hours per week will be devoted to Cements and Concrete laboratory. Textbook: *Design of Reinforced Concrete Structures* (Seventh Edition) – Winter, Urquhart, O'Rourke, Nilson.

130. CONSTRUCTION MANAGEMENT

IV – 1 – – 2 –

A study of the management and control of engineering-construction projects. Management is discussed in relation to planning, cost estimating, value prediction, scheduling, bidding and labour relations. Control is maintained through accounting records leading to financial statements. Textbook: *Control and Management of Capital Projects* – J. W. Hackney.

135. ENGINEERING GRAPHICS

I – 1, 3, 4, 5, 6, 7, 8, 9 1 3 1 3

An introductory course designed to give the student a foundation in spatial visualization and an appreciation of the various graphical techniques used in representation and in the solution of engineering problems. The lectures are mainly concerned with descriptive geometry, i.e., with the principles of orthographic, oblique and perspective projection and their use in solving problems involving points, lines and surfaces. In the laboratory, problems are solved in descriptive geometry, engineering drawing, empirical equations, charts and graphs. Both instrument and freehand techniques are used. Textbooks: *Graphic Science* – French and Vierck, 2nd edition; *Graphic Science Problems* – Vierck and Hang, 2nd edition.

137. THE ENGINEER AND HIS ENVIRONMENT

II – 1 1 3 1 3

An introduction to the role of the civil engineer in the solution of society's problems. Lectures, seminars and discussion periods by staff of all areas of Civil Engineering and guest speakers. Projects on qualitative solutions to comprehensive engineering problems.

Students work in groups of about 10, and consult staff in Civil Engineering as well as outside agencies.

138. ENGINEERING PRESENTATION

II – 1 1 3 – –

Principles, methods and practice in engineering report writing including methods and procedures of presentation, organization, synopses, nomographs, overlays, drawings and photographs. Practice in presentation in those data, sketches and mechanical drawings necessary for a draughtsman to produce formal engineering drawings.

140. MATHEMATICAL APPLICATIONS

IV – 1A, 1C – – 2 1½

The formulation, discussion and solution of certain civil engineering problems by numerical methods including relaxation techniques. Electronic digital computers are employed in appropriate cases.

141. PROBABILITY AND STATISTICS

III – 1 2 – – –

Topics to be considered include definition of probability, binomial, poisson and normal distributions, frequency and sampling distributions. Examples of estimation, hypothesis testing and an introduction to the analysis of variance will be covered.

142. ENGINEERING MATHEMATICS

III – 1 3 2 – –

Higher order linear differential equations with constant coefficients, introduction to partial differential equations, numerical integration, solution of initial value problems by numerical methods, introduction of finite differences, solution of linear equations, an introduction to the analogue computer.

145. COMPUTER PROGRAMMING

II – 1 2 2 – –

This subject is intended to develop reasonable proficiency in computer programming techniques and to introduce the more elementary numerical analysis procedures. The use of flow charts is emphasized and the Fortran IV language is studied extensively from a user's point of view. In addition, problem-oriented languages such as COGO and STRUDL are introduced.

153. SURVEYING

II – 1 2 1½ 1 1½

General principles and practice of surveying including: measurement of horizontal distances, horizontal angles, vertical distances. Survey calculations, sources of errors, corrections and adjustments. Route surveying, construction surveying and introduction to air-photo interpretation and photogrammetry.

155. SURVEYING

II – 9 1 – 1 –

Introduction to surveying principles and practice. Theory and use of surveying instruments. Survey computations and error analysis, including quantity calculations. Mine surveys, topographic surveys, and introduction to practical astronomy. Textbooks: *Surveying Practice* – Kissam; *Surveying for Civil Engineers* – Kissam.

156. SURVEYING LABORATORY

II – 9 – 1½ – 1½

First term – field problems using the transit, level and tape. Second term – survey computations related to Course 155.

158. SURVEY CAMP

Course 1, III Year; Aug. 25 to Sept. 12 – Dorset or Gull Lake; Course 9, III Year; Sept. 2 to Sept. 12 – Gull Lake.

Course 1:

(*a*) Adjustments of level and transit, (*b*) Route Surveys, (*c*) Higher Surveys, (*d*) Topographic Surveys, (*e*) Practical Astronomy, (*f*) Photo Interpretation.

Course 9:

(*a*) Topographic Surveying and Mapping, (*b*) Underground Surveying, including Shaft Plumbing and Use of Mine Surveying Instruments, (*c*) Route Surveys, Curve Layout, and Earthwork Quantity Computations, (*d*) Astronomic Observations for Time and Azimuth.

Students in Courses 1 and 9 will be required to take the Survey Camp between the Second and Third Years. Application to defer attendance at the Camp must be made to the Secretary of the Faculty before July 15.

167. SURVEY CAMP

Course 1B, IV year; Aug. 18 to Sept. 12, Gull Lake.

Triangulation, trilateration, electronic distance measurements, traverses, levelling and astronomical observations by precise methods.

168. GEODETIC ADJUSTMENTS

IV – 1B 1 3 1 3

The theory of the adjustment and analysis of geodetic measurements. The design and statistical analysis of engineering control surveys. The application of the electronic computer to survey adjustment problems. Laboratory periods deal with the problems of design, analysis and adjustment of control surveys. Heavy emphasis is placed upon the programming and solution of the above problems by electronic digital computer.

170. PHOTOGRAMMETRY II

IV – 1B 1 3 1 1½

Review of elementary matrix theory, orthogonal and skew-symmetric matrices, theory of model restitution, linear conformal transformations in 2-space and 3-space and their applications in photogrammetry, methods of serial triangulation, non-linear transformations in 2-space and 3-space and their applications in the adjustments of strips and blocks of models, analytical model reconstruction. Laboratory work consisting mainly of computer programming of photogrammetric problems.

172. ASTRONOMY

IV – 1B – – 1 3

Precise determination of time, latitude, longitude and azimuth as applied to geodetic surveys. Observations and problems.

174. ENGINEERING AND LEGAL SURVEYS

IV – 1B 1 – 2 –

Construction surveying problems dealing with prismoidal volumes and corrections, hydrographic surveying, tunnel surveying, circular curve intersections, area computations, chronological order of land subdivision and layout from early township patterns to present-day subdivisions, the weighing of survey evidence in the retracement of construction and legal surveys, and the preparation of legal surveys.

175. GEODESY AND ELECTRONIC SURVEYING

IV – 1B 2 1½ 2 3

Ellipsoidal geometry, deflections of the vertical, reduction of geodetic measurements to the ellipsoid, geodetic position computations, electronic surveying, map projections. Problems in geodetic computations, the reduction of electronic distance measurements, the calculation of geodetic positions, map projection co-ordinates.

180. ENVIRONMENTAL ENGINEERING

II – 1, III – 1 – – 2 –

This subject introduces problems related to the source and fate of air, water and soil pollutants and their effect on society. The control of pollution by prevention and disposal is discussed.

182. MUNICIPAL ENGINEERING

III – 1 – – 2 2
IV – 1C (elective) – – 3 2

Quantities of water and waste water, hydrology, waste water collection systems, water distribution systems, municipal roads, refuse disposal, administration and financing of municipal works. Laboratory: Design Problems supplementing lecture material. Textbooks: *Water and Waste Water Engineering* – Fair, Geyer and Okun, Volume I. *Design and Construction of Sanitary and Storm Sewers* – WPCF Manual. References: *Water Supply and Pollution Control* – Clark and Viessman. *Hydrology for Engineers* – Linsley, Kohler and Paulhus.

183. POLLUTION CONTROL ENGINEERING

IV – 1C (elective) 3 2 – –

Air pollution control, water supply and purification, municipal waste water treatment, industrial waste water treatment, soil pollution control.

184. ENVIRONMENTAL PLANNING

IV – 1C (elective) (not offered in the session 1969–70) 3 2 – –

Environmental planning; physical, economical, biological, sociological, spiritual; new theory based on the philosophy of seven dimensions; emerging form of urban life; shaping the metropolis; metropolis within the region; green belts and satellites; pollution control; redevelopment.

185. TRANSPORTATION SYSTEMS

III – 1 – – 3 2

Function of transportation, national and urban transportation policy issues, characteristics of transportation systems, principles of location, geometric design of highways and railways, planning procedures.

187. TRAFFIC ENGINEERING

IV – 1C (elective) 3 2 – –

Urban transportation planning, traffic studies, forecasting models, characteristics of traffic flow, traffic control at intersections, methods of project evaluation. Textbook: *Traffic Engineering Handbook*. References: *Principles and Techniques for Predicting Future Demand for Urban Area Transportation* – Martin, Memmott, and Bone; *Highway Capacity Manual*.

188. TRANSPORTATION ENGINEERING

IV – 1C (elective) – – 3 2

Characteristics of Transportation Systems, Railway and Airport Engineering, Theory of Traffic Flow, Behaviour and Design of Flexible and Rigid Pavements. Reference books: *Introduction to Transportation Engineering* – Hay; *Planning & Design of Airports* – Horonjeff; *Soil Mechanics for Road Engineers* – D.S.I.R.; *Principles of Pavement Design* – Yoder; *Poisson & Traffic* – Eno Foundation.

189. AIR PHOTO INTERPRETATION

IV – 1C (elective) 3 2 – –

The principles of interpretation of aerial photographs; processes of formation and erosion of landforms, both unconsolidated and consolidated, with particular emphasis on glaciation, their patterns as seen on aerial photographs, their identification and evaluation, and the engineering problems involved; location of granular materials; soil mapping; investigations from airphotos for highway, powerline, and pipeline locations, damsites and flood control structures; delineation of drainage areas and drainage structure location; classification of muskeg areas and prediction of depth; land use classification. One day field trip, including field soil testing.

191. SOIL MECHANICS AND FOUNDATIONS

III – 1 2 1½ 2 1½

Identification and classification of soils for engineering purposes, weight-volume relationships, compaction, permeability and drainage characteristics, effective stresses, settlement, shearing strength, site exploration and soil sampling. Bearing capacity, footings, consolidation and settlement, lateral pressure, retaining walls, braced cuts and cofferdams, pile and caisson foundations, sheet pile bulkheads, slope stability, flow nets, dewatering. In addition to lectures there will be laboratory testing and problem periods.

192. SOIL MECHANICS AND FOUNDATIONS

IV – 1A, 1C 2 – 1 2

Shearing strength, bearing capacity, footings, consolidation and settlement, lateral pressures, retaining walls, braced cuts and cofferdams, pile and caisson foundations, sheet pile bulkheads, slope stability, flow nets, dewatering. Laboratory testing and problem periods. No laboratory reports to be written outside assigned laboratory hours.

193. FOUNDATIONS AND EARTHWORKS

IV – 1C (elective) – – 3 2

Design and construction of: Foundations for buildings, bridges and other structures including excavation, footings, piling, caissons; Retaining walls, sheet pile bulkheads, tunnels; Fills, embankments, earth-fill and rock-fill dams including seepage, dewatering and grouting. Geotechnical processes and field measurements and control.

194s. ENGINEERING GEOLOGY

IV – 1C (elective) 3 2 – –

The study of engineering practice from a geological point of view. The behaviour of rocks and soils in building and engineering construction, foundations, tunnels, dams, and flood-control works with reference to the importance of the mineral composition of earth and rock materials, their geomorphic and geologic features and their stress history. Engineering case studies will include examination of groundwater, frost and landslide conditions, shoreline engineering, construction in permafrost, earthquake problems, and field investigations.

195. MINING

II – 9 1 – 1 2

A combined lecture and laboratory subject in the principles of mining and its unit processes. Emphasis is placed on the statistical approach to sampling calculations.

196. MINING TECHNOLOGY AND MINERAL DRESSING

III – 9 2 – 2 –

An introduction to mining practice with emphasis on current mining methods as applied to geological situations and stress environments; current practices in mineral beneficiation processes.

197. MINE OPERATION AND ADMINISTRATION

IV – 9 2 – 2 –

Mine operation with special attention paid to mine services; administration dealing with aspects of economics, industrial engineering, finance, and industrial relations.

198. MINING LABORATORY

IV – 9 – 3 – 3

Problems in mine layout involving shaft location and size; mine development; choice of stoping methods, mining rate, and mine equipment; time and cost schedules; ore reserve calculations.

DEPARTMENT OF MECHANICAL ENGINEERING

302. ENGINEERING THERMODYNAMICS

II – 1 – – 1½ –

The fundamentals of engineering thermodynamics. The First and Second Laws. Properties of substances. Heat transfer. Heat exchangers. Compressors, fans, pumps, reciprocating engines and turbines. Vapour and gas power cycles. Refrigeration. Air-conditioning.

P. B. Hughes

308. HEAT ENGINEERING

III – 3 2 – – –

Applications of thermodynamics to machines, including: background to the development of heat engines; basic steam power plant cycles and design; internal combustion engines and cycles; combustion calculations; fuel and exhaust products analysis; power plant testing; heat transmission; psychrometry and air conditioning.

A. B. Allan

309. ENGINEERING THERMODYNAMICS

III – 3 2 – 2 –

Fundamentals of the effects of heat on fluids, including: first and second laws of thermodynamics; ideal processes using gases and vapours; reversibility, availability and entropy; properties of real and ideal fluids; processes and cycles for gas and vapour power plants; processes and cycles for refrigeration.

F. C. Hooper

310. HEAT ENGINEERING LABORATORY I

III – 3 – 3 – 3

Complementary to lecture subjects 308 and 309. The experimental work, conducted on a broad range of heat and power equipment, is intended to offer experience in the design, organization and execution of experimental investigations of thermal apparatus, in the application and evaluation of the associated instrumentation, in the treatment of the data, and in the interpretation and reporting of the work. Textbook: *The Engineering Réport in the Undergraduate Laboratory* – Hughes.

313. HEAT ENGINEERING

III – 5nt 1 – 1 –

This course consists of a study of the fundamental concepts of macroscopic thermodynamics, and their applications to closed and open dynamic systems. An examination of the principal power cycles is undertaken in relation to the properties of the working media involved. Emphasis is placed on a thorough understanding of the three basic laws of thermodynamics. Textbook: *Concepts of Thermodynamics* – Obert. Reference books: *Engineering Thermodynamics* – Hall and Ibele. *Thermodynamics* – Van Wylen

C. A. Ward

314. HEAT ENGINEERING LABORATORY

III – 5nt – 3 – 3

This laboratory is complementary to lecture subject 313. The course emphasizes the philosophy and techniques used in the experimental investigation of the performance of heat engineering equipment. Textbook: *The Engineering Report in the Undergraduate Laboratory* – Hughes.

319. HEAT TRANSFER

IV – 3 2 – 2 –

Fundamentals of heat transfer with practical application, steady state conduction, natural and forced convection for laminar and turbulent flows, radiation heat transfer, transient systems, combined heat transfer processes, introduction to mass transfer, practical applications, heat exchangers. Textbook: *Principles of Heat Transfer – F. Kreith.*

F. C. Hooper

320. HEAT ENGINEERING LABORATORY

IV – 3 – 1½ – 1½

Problems and experiments designed to accompany Lecture Course 319.

322. MICROSCOPIC THERMODYNAMICS

IV – (elective) 2 – 2 1½

Elementary kinetic theory concepts such as collision frequency, distribution functions transport phenomenon, thermodynamic properties, phase space and the Boltzmann equation; classical statistical mechanics concepts of ensembles, partition functions and their use; introduction to quantum mechanics; the quantum statistical mechanics of Bose-Einstein and Fermi-Dirac systems, translational, rotational, vibrational, electronic, nuclear partition functions; other related topics. Textbook: *Microscopic Thermodynamics* – Pierce.

C. A. Ward

323. THERMAL POWER GENERATION

IV – 3 (elective) 2 – 2 1½

Plants and processes in major production, overall design and heat balance in steam plants, non-central power production, characteristics of portable power units, fossil

fuels and nuclear energy, combustion theory and introduction to combustion problems, principles and potential of new devices currently under development, magnetohydrodynamics power, fuel cells, thermionic and thermoelectric power.

P. B. Hughes

328. HEAT TRANSFER

IV – 5nt – – 2 –

Steady state and transient conduction, surface and gas radiation, convection, boiling, condensation and combined mechanisms are considered. Special attention is given to analogue and computational procedures and to consideration of the manner in which novel or complex problems may be approached. Textbook: *Heat Transmission* – McAdams.

F. C. Hooper

331. THERMAL ENERGY CONVERSION

IV – 5nt 3 – 3 –

The thermodynamics and gas dynamics of thermal energy conversion. Steam power cycles, nuclear reactor and fossil fuel energy sources, magnetohydrodynamics power generation, fuel cells, combustion, refrigeration, new trends and research developments.

D. S. Scott

332. HEAT ENGINEERING LABORATORY

IV – 5nt – 3 – 3

This laboratory is complementary to lecture course 331, and an extension of course 314. The techniques of testing, the design of experiments, the application of instrumentation, and the organization and reporting of performance tests are emphasized.

333. FLUID MECHANICS AND HYDRAULICS

III – 1 2 – 2 3

Properties of fluids, fluid statics, pipe-line flows, compressible flows, momentum and energy equations, dimensional analysis, free surface flows, flow around submerged bodies, turbulent flows, pumps, water hammer and surge tanks.

D. F. James

334. FLUID MECHANICS I

III – 3 2 – 2 3

Introductory concepts; fluid properties, dimensional analysis; hydrostatics; kinematics and dynamics of flow; irrotational flow and vorticity; dynamic lift; laminar flow; turbulent flow; applications to closed-conduit and open-channel flow; one-dimensional compressible flow.

G. R. Lord

337. FLUID MECHANICS AND THERMODYNAMICS

III – 4 2 3 – –

Fluid properties and equation of state, momentum and energy equations; dynamics of flow, laminar and turbulent flow, closed-conduit flow.

Laws of thermodynamics, the Carnot cycle, real and ideal fluids, power cycles, psychrometry and heat transfer.

D. F. James, P. B. Hughes

338. FLUID MECHANICS

III – 5C 2 3 – –

Presentation of fundamentals of continuum fluid motion; introductory concepts; kinematics and dynamics of flow; irrotational motion; viscous laminar and turbulent flow; thermodynamic relationships; gravity effects; applications.

J. F. Keffer

339. FLUID MECHANICS

III – 6 2 3 – –

Introductory concepts; fluid properties; fluid statics; kinematics and dynamics of flow; laminar and turbulent flow; closed-conduit and open-channel flow; compressibility effects; drag and lift on submerged bodies; elementary turbomachinery.

I. G. Currie

340. FLUID MECHANICS

III – 5nt 2 3 2 3

A fundamental approach to the mechanics of fluid motion; continuum concepts; kinematics and dynamics of flow; irrotational motion; vorticity; laminar flow solutions; turbulent motions; applications to conduit flow; thermodynamic relationships; elementary thermal transport; free surface waves; fluid machinery.

J. F. Keffer

341. FLUID FLOW AND HEAT TRANSFER

III – 8 2 – 2 3

A study of the forces and motion produced by various fluid properties. Gravitational, viscous and inertial forces are considered in detail. Momentum, energy and continuity relation, boundary-layer approximation, turbulence, flow in pipes and around submerged bodies. Steady-state conduction in one dimension; extended surfaces; heat conduction with two or more independent variables; forced convection and dimensional analysis; heat transfer by free convection; radiant heat transfer; heat transfer by combined conduction and convection; heat transfer in liquid metals.

A. H. Abdelmessih, H. J. Leutheusser

343. HYDRAULIC ENGINEERING

IV – 1 2 3 – –

Application of fluid mechanics to civil engineering, surges, water hammer hydraulic machinery. Introduction to hydrology – precipitation, runoff, snow melt, infiltration, ground water, stream flow, hydrographs.

W. D. Baines

344. APPLIED FLUID MECHANICS

IV – 3 2 1½ 2 1½

Pipe, networks; one dimensional gas dynamics including simple area change, simple friction, simple heating, generalized flow and normal shock waves; hydraulic transients including surges and water hammer; flow machines; fluid power circuits; other topics of engineering significance.

Problems and experiments in applied fluid mechanics.

H. J. Leutheusser

346. FLUID MECHANICS II

IV – 3 (elective) 2 – 2 1½

Flow of an ideal fluid, complex variable analysis, lift, finite wing theory, viscous fluid flow, simple solutions of Navier-Stokes equations, lubrication theory, boundary-layer theory, drag of streamline bodies, turbulent flow, diffusion in turbulence, dynamics of submerged bodies, introduction to aeroelasticity, free surface phenomena.

W. D. Baines

351. DYNAMICS

II – 3 3 1 – –

Calculus of vectors; particle motion; systems of particles; rigid bodies; virtual work and D'Alembert's principle; introduction to Lagrange equations; introduction to mechanical vibrations. Textbook: *Housner and Hudson* – Applied Mechanics-Dynamics.

F. P. J. Rimrott

352. DYNAMICS

II – 7 2 – 1 –

Dimensional units; vectors; kinematics, rectilinear and angular motion, plane motion, projectiles; satellite orbits, rigid body concept, relative motion with respect to translating and to rotating vehicles; kinetics, force, d'Alembert's principle, rotation, translation, vibration of mechanical and electrical systems, work, energy, conservation of energy, power, impulse, momentum, rockets, jets, fluid mechanics, impact, balancing, centrifugal and Coriolis' force, critical speeds, gyroscopic effect. Reference book: *Dynamics* – Merriam.

F. P. J. Rimrott

353. DYNAMICS LABORATORY

II – 7 – 1½ – 1½

Course 7, II Year; 1½ hrs. problems per week, both terms. Problems in kinematics and kinetics to support subject 352.

354. DYNAMICS LABORATORY

II – 3 – 1½ – –

Problems to accompany lecture course 351.

356. DESIGN OF MACHINE ELEMENTS

II – 3 – – 2 –

Course 3, II Year; 2 hrs. lectures per week, second term. Standard methods for the design of belts, shafts, spur gears, bearings, brakes, clutches, couplings, power screws, fasteners, rivets and welded components. Textbook: *Mechanical Engineering Design* – Shigley.

I. W. Smith

357. DESIGN LABORATORY

II – 3 – – – 3

Design of machine parts and simple machines, including drafting and assembly layout. Fits and tolerances.

358. THEORY OF MACHINES

II – 3 – – 2 3

Equations for accelerated motion of mass applied to the analysis of machine elements. Velocity, acceleration, force distribution, speed fluctuation and balancing of machine parts and machines. Cams, gears, flywheels and linkage kinematics. Textbook: *Kinematics and Dynamics of Machinery* – Maxwell.

G. E. Godfrey

360. SYSTEMS DYNAMICS

III – 3 1 – 1 –

Setting up of the differential equations of physical systems; frequency response and bandwith concepts; the analogue computer; transducers and instrumentation; frequency response and transient response, consideration in the matching of processes.

D. L. Allen

361. VIBRATIONS

III – 3 2 – – –

Single-degree-of-freedom systems, damped and undamped; multi-degree-of-freedom systems; method of determining natural frequencies; characterization of physical systems by mathematical models; response of such systems to steady-state single-frequency excitation and to transient pulses; beams and strings.

B. Tabarrok

362. DYNAMIC MEASUREMENTS LABORATORY

III – 3 – 3 – 3

A combined laboratory course for Vibrations (361) and Systems Dynamics (360). Includes: comparative experiments with transducers; analogue computer study of transient and frequency response behaviour of physical systems; vibration experiments; experimental study of electrical-mechanical-fluid-thermal analogies; measurements of the process dynamics of a variety of systems, including consideration of the optimum choice of transducers and instrumentation and the comparison of transient and frequency response.

363. ENGINEERING DESIGN

III – 3 – – 2 –

Approach to engineering design; problem definition; generating and comparing concepts; synthesis-analysis-evaluation decisions under realistic situations. Engineering examples and small design projects utilizing available background of mathematics, mechanics, circuits and thermodynamics. Specific attention is given to such subjects as springs, curved beams and experimental stress analysis.

I. W. Smith

364. ENGINEERING DESIGN LABORATORY

III – 3 – – – 3

A laboratory course complementary to the lectures of subject 363, Engineering Design.

365. EXPERIMENTAL STRESS ANALYSIS

III – 5nt, 5p 2 – 1 –

The elementary concepts of the theory of elasticity will be given. The experimental techniques of measuring stress or strain will be studied; these techniques include strain-gauge, photoelastic, brittle-coating and moire methods.

G. E. Godfrey

366. EXPERIMENTAL STRESS ANALYSIS LABORATORY

III – 5nt, 5p – – – 3

Problems and experiments designed to accompany lecture course 365.

G. E. Godfrey

367. APPLIED MECHANICS

IV – 3 2 – 2 –

Beams on elastic foundations, energy methods, torsion of non-circular cylinders and open sections, thick discs, composite cylinders, equations of two-dimensional elasticity, description of continuous media. Review of particle dynamics, Lagrange's equations, Hamilton's principle, gyroscopic dynamics, non-linear vibrations, phase plane, vibrations of continuous elastic media, rocket dynamics, outer space dynamics.

B. Tabarrok

368. APPLIED MECHANICS LABORATORY

IV – 3 – 1½ – 1½

Problems and experiments designed to accompany lecture course 367.

374. MANUFACTURING SCIENCE

IV – 3, 4 (Fall Term Elective) 2 – – –

Review of traditional production processes including casting, forging, cutting, etc.; science of metal removal; economics of production; sintering, EDM, ECM, explosive forming, etc.; numerical control and automation. Textbooks: *Processes and Materials of Manufacture* – Lindberg; *Manufacturing Analysis* – Cook.

I. W. Smith

375. SCIENCE OF DESIGN

IV – (Spring Term Elective)) – – 2 1½

Morphology of design decision making; computer-aided graphic and design methods, optimization, reliability, value engineering.

I. W. Smith

380. DIFFERENTIAL EQUATIONS

II – 3 – – 2 1

Engineering applications of elementary differential equations, to include such topics as operational methods, elementary nonlinear equations, simultaneous differential equations.

Staff in Mechanical Engineering

386. ENGINEERING MATHEMATICS I

III – 3 3 1 3 1

Analytical techniques used in mechanical engineering, including such topics as: numerical methods, vector analysis, complex variables, differential equations with variable coefficients, Sturm-Liouville systems; introduction to partial differential equations.

A. H. Abdelmessih, D. S. Scott

390. ENGINEERING MATHEMATICS II

IV – 3 (elective) 2 – 2 1½

Partial differential equations in engineering including such topics as Fourier series and integrals, integral transforms, classification of partial differential equations, solutions of the Laplace, diffusion and wave equations.

I. G. Currie

391. CONTROL SYSTEMS

IV – 3 2– 2 –

Analysis and synthesis of linear feedback control systems, by frequency response methods and the s-plane approach; application to some common systems for the control of industrial machinery and processes; introduction to non-linear, to sampled-data and to digital control systems.

J. VandeVegte

392. CONTROL SYSTEMS LABORATORY

IV – 3 – 1½ – 1½

Problems and experiments designed to accompany lecture course 391.

394. CONTROL ENGINEERING

III – 4 – – 2 3

An introduction to the dynamic behaviour of linear systems; the feedback principle; stability of linear control systems; the convolution theorem; transfer functions of

linear systems; analysis of linear control systems; introduction to servo-mechanism technology. Problems and laboratory experiments will accompany the lectures.

J. S. Ansari

398. CONTROL SYSTEMS

IV – 5g, 5nt 1 – 2 –

A course in linear and non-linear control systems.

J. VandeVegte

399. CONTROL SYSTEMS LABORATORY

IV – 5g, 5nt – – – 3

A laboratory course accompanying subject 398.

DEPARTMENT OF INDUSTRIAL ENGINEERING

414. ELEMENTS OF INDUSTRIAL ENGINEERING

II – 4 2 – 2 –

A broad survey of both old and new elements of Industrial Engineering, with selected reading and essay assignments, including work study, wage determination, controls of production, quality and cost, mathematical models of production and distribution systems, computer simulation techniques, operational research, human factors studies, and management science.

B. Bernholtz, W. Davidson

415. AUTOMATIC CONTROL OF PROCESSES

IV – 4 2 – 2 –

Automatic control in the process industries and in the control of machine tools. Problems of on-line computer control. Relation to over-all problems of system planning and management control.

J. M. Tusiewicz

417. INDUSTRIAL ENGINEERING SEMINAR

IV – 4 – 1 – 1

Members of the staff in Industrial Engineering, and invited speakers prominent in the academic, governmental, and business communities, will conduct a series of talks followed by general discussion. Two essays, on one or more of the subjects discussed, will be required.

418. MANAGEMENT SCIENCE

IV – 4 2 1½ 2 1½

The course presents the basic principles of decision-making. It includes such concepts as: economic rent or opportunity costs, the value of accurate information, aversion to risk in terms of von Neumann-Morgenstern utility, the analysis of data by Bayesian

inference, the expression of consumer choice by means of indifference curves, pricing in a competitive market, and the solution to bargaining situations in the theory of games. Prerequisites are elementary calculus, probability theory and linear algebra.

T. A. Lambe

419. OPERATIONAL RESEARCH II

IV – 4 3 3 3 3

Mathematical techniques of O.R. such as linear and non-linear programming, graphs and networks (max. flow – min. cut theorem). Application of techniques to problems in production scheduling and inventory control.

Systems of linear differential equations, Markov theory, applied to queueing, inventory, transportation, maintenance, reliability, replacement, and information processing problems. Prerequisites are probability and statistics, linear algebra, and elementary differential equations.

J. A. Buzacott, M. J. M. Posner

421. THESIS PROJECT

IV – 4 – 6 – 6

Design and analysis of an engineering system to satisfy certain objectives and requirements (e.g. the production of a specific product). This project will provide the student with an opportunity to apply the knowledge and techniques of analysis acquired in all the other Industrial Engineering subjects. The work will be carried out under the supervision of staff members. Progress reports and a written thesis are required.

Staff in Industrial Engineering

422. COMPUTER PROGRAMMING I

II – 4 1 1½ 1 1½

Coding and programming for the digital computer; machine organization, machine language and symbolic compiler language (FORTRAN IV); number representation and conversion. Laboratory exercises are drawn from the fields of engineering and applied science, as well as from those of data processing and elementary compilation.

R. W. P. Anderson

423. COMPUTER PROGRAMMING II

III – 4 1 1½ 1 1½

An extension of the Second Year subject Computer Programming I. More advanced discussion of general and specialized compiler languages and their application in business, engineering and other fields; simulation, data processing, and list processor languages; monte carlo methods; GPSS, SIMSCRIPT, COBOL, etc. Laboratory problems are selected to complement the lecture material.

R. W. P. Anderson, S. H. Cohn

424. OPERATIONAL RESEARCH I

III – 4 2 2 2 2

Introduction to the use of mathematical models for allocation, distribution, scheduling, queueing, inventory, reliability, and maintenance. Prerequisites are probability and statistics, linear algebra and calculus.

J. A. Buzacott, M. J. M. Posner

425. HUMAN FACTORS ENGINEERING AND EQUIPMENT DESIGN

IV – 4 2 – – –

The design of equipment and systems of equipment for effective use by human beings.

P. J. Foley

426. MAN AS AN INDIVIDUAL

IV – 4 2 – – –

The study of individual differences, with particular reference to problems of measurement of psychological features.

P. J. Foley

427. MAN AS A MACHINE

IV – 4 – – 2 –

Detailed study of the biological bases and correlates of behaviour with emphasis on the analysis of sensory systems.

P. J. Foley

428. ORGANIZATIONAL PSYCHOLOGY

IV – 4 – – 2 –

Analysis of the determinants of behaviour within organizational structures.

P. J. Foley

429. SYSTEMS THEORIES I

IV – 4 2 1½ – –

Computer simulation models. The theory will be developed and applied to problems in the design and analysis of queueing, inventory, maintenance, reliability, transportation, and resource allocation systems.

J. G. C. Templeton

430. SYSTEMS THEORIES II

IV – 4 – – 2 1½

Introduction to information theory; topics in optimization theory.

J. G. C. Templeton

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

600. CHEMISTRY

I – 1, 3, 4, 6, 7, 8, 9 2 – 2 –

Chemical theory, with industrial and engineering applications.

The Staff in Chemical Engineering

601. CHEMICAL LABORATORY

I – 1, 3, 4, 5, 6, 7, 8, 9 – 3 – 3

A laboratory course illustrating the fundamental laws of chemistry as dealt with in the lecture course, and providing an introduction to chemical analytical methods.

W. F. Graydon, M. J. Phillips, S. Sandler, A. M. Rozeiu

602. CHEMISTRY

I – 5 2 – 2 –

Introductory physical chemistry: the gas laws, chemical equilibria, elementary solution chemistry, thermochemistry. Problems dealing with industrial and engineering applications.

W. H. Burgess

608. PHYSICAL CHEMISTRY

II – 5 2 – 2 –

The themes discussed are conservation, equilibrium and rate of change in chemical systems. These are applied to topics in thermo-chemistry, phase equilibrium, reaction equilibrium, including reactions in cells, and reaction kinetics. Reference books: *Physical Chemistry*, by F. Daniels and R. A. Alberty, 3rd ed.; *Physical Chemistry*, by W. J. Moore, 3rd ed.

C. E. Chaffey

609. PHYSICAL CHEMISTRY LABORATORY

II – 5 – 1½ – 1½

Experimental work and problems periods to accompany subject 608. In the second term, each student performs a laboratory investigation of an individual problem of a research type. Alternate periods are devoted to solving assigned problems.

C. E. Chaffey

613. ANALYTICAL CHEMISTRY

II – 6

This course commences on the Wednesday following the first Monday in September, and continues until the opening of the Fall Term. All the working time will be spent on systematic qualitative and quantitative inorganic analysis and machine computation. Textbook: *Textbook of Inorganic Analysis* – Kolthoff and Sandell.

J. W. Smith, W. A. M. Hewer, J. Binkiewicz

614. ANALYTICAL CHEMISTRY LABORATORY

II – 6 – 9 – –

A continuation of subject 613.

J. W. Smith, W. A. M. Hewer, J. Binkiewicz

615. ANALYTICAL CHEMISTRY

II – 6 2 – – –

Equilibrium considerations in quantitative analysis.

J. W. Smith

617. INORGANIC CHEMISTRY

II – 6, 8, 9 1 – 2 –

The constitution of matter and classification of the elements; systematic inorganic chemistry.

R. L. Hummel, R. E. Jervis

619. CHEMICAL ENGINEERING SCIENCE LABORATORY

II – 6 – – – 7½

Experiments illustrating the kinetic and equilibrium principles of chemical engineering. Mass and heat balance calculations. One laboratory report per week.

I. H. Spinner, W. A. M. Hewer, C. P. Brockett, M. J. Phillips

620. PROCESS CALCULATIONS

II – 6 – 3 – 3

Process calculations in chemical engineering. Textbook: *Basic Principles and Calculations in Chemical Engineering* – Himmelblau.

J. W. Smith, I. H. Spinner

622. PHYSICAL CHEMISTRY

II – 6 2 – 2 –

The themes discussed are conservation, equilibrium and dynamics in chemical systems. These are applied to topics in thermochemistry, phase equilibrium, reaction equilibrium, including reactions in cells, surface phenomena and reaction kinetics. Reference books: *Physical Chemistry* – F. Daniels and R. A. Alberty, 3rd ed.; *Physical Chemistry* – W. J. Moore, 3rd ed.

R. W. Missen

625. REACTION KINETICS

III – 6 1 – 1 –

Chemical kinetics; principles of adsorption and colloid chemistry.

W. H. Burgess

626. SYNTHETIC CHEMISTRY

III – 5c 2 – 2 –

A course in synthetic chemistry covering the principles of systematic organic chemistry and systematic inorganic chemistry.

R. Woodhams

627. CHEMICAL LABORATORY

III – 6 – 6 – 6

A laboratory course to accompany subject 640. One laboratory report.

W. F. Graydon, Z. May

628. ORGANIC CHEMISTRY

III – 6 2 – 2 –

An introductory course in organic chemistry.

J. G. Breckenridge

629. ORGANIC CHEMISTRY LABORATORY

III – 6 – 6 – 9

A laboratory course accompanying subject 628.

W. H. Rapson, Z. May

630. INDUSTRIAL CHEMISTRY

III – 6 2 – 1 –

Selected topics in the chemical process industries. The course illustrates how the principles of chemistry, engineering and economics are applied in industry. Textbook: *Chemical Process Industries* – R. N. Shreve.

Staff in Chemical Engineering

631. INTRODUCTION TO MASS AND HEAT TRANSFER

II – 6 2 – 2 –

The fundamental theory and practice used in transfer operations in chemical engineering. Energy and mass transfer are considered in the study of the flow of fluids, fluidization of solids, heat transfer, and evaporation of solutions. Textbook: *Principles of Unit Operations* – Foust *et al.*

W. G. MacElhinney

632. FLUID MECHANICS

III – 6 – – 2 –

Applications of the fundamentals of fluid mechanics in chemical engineering, with emphasis on single- and two-phase flow with and without heat transfer, fluid-particle dynamics and non-Newtonian fluid flow. Textbook: *Chemical Engineering*, Vols. I and II – Coulson and Richardson.

M. E. Charles

633. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

III – 6 1 1 1 1

The first term is devoted to analysis and solution of chemical engineering problems which require knowledge of the rational design of experiments, treatment of experimental data and tests of hypotheses. The second term is devoted to applications of differential equations to problems of chemical engineering interest; emphasis is on the formulation of differential equations, together with their solution by analytical and

numerical methods. Reference Books: *Probability and Statistics for Engineers* – I. Miller and J. E. Freund. *Engineering Statistics* – A. H. Bowker and G. J. Lieberman. *Applied Differential Equations* – M. R. Spiegel.

I. H. Spinner, R. W. Missen

640. CHEMICAL ENGINEERING THERMODYNAMICS

III – 5c, 6 2 2 2 2

A tutorial course in classical thermodynamics with problems in the field of applied chemistry and chemical engineering. Special emphasis is placed on chemical processes and compositional changes.

W. F. Graydon

641. CHEMICAL ENGINEERING RATE PROCESSES

III – 5c – – 3 –

Introduction to mass, momentum and energy transport. Kinetic theory of gases, calculation of transport properties; analytical solutions of problems in viscous flow, heat conduction and mass diffusion; turbulent transfer coefficients; applications to chemical engineering systems. Textbook: *Transport Phenomena* – Bird, Stewart and Lightfoot.

O. Trass

642. CHEMICAL ENGINEERING PROBLEMS AND LABORATORY

III – 5c – 9 – 7½

Problems and laboratory experiments illustrating topics discussed in subjects 640, 641, and 626.

Staff in Chemical Engineering

650. MASS TRANSFER OPERATIONS

III – 6 2 1 2 1

IV – 6c 2 – 2 –

The theory and practice of mass transfer operations in chemical engineering are discussed. Many problems in distillation, extraction, absorption, and other operations illustrate the course. Textbook: *Mass Transfer Operations* – 2nd Ed. R. E. Treybal.

D. Mackay

651. CHEMICAL PLANT DESIGN

IV – 6 2 6 – –

The lectures take a systems approach to the design of chemical plant, proceeding from the origin through major design considerations to technical and economic feasibility. Considerations applying to overseas situations, and the relationship of design to operation are included. In the plant design laboratory teams of students design and evaluate a particular plant. Textbook: *Chemical Engineering Plant Design* – Vilbrandt and Dryden. Reference book: *Fundamentals of Cost Engineering in the Chemical Industry* – Bauman.

M. Wayman, D. Mackay

652. CHEMICAL ENGINEERING LABORATORY

IV – 5c, 6 – 9 – –

A laboratory course to accompany subjects 631, 632, 650, and 651. Bench and pilot plant experiments are carried out to study a variety of unit operations such as fluidization, heat transfer, evaporation, filtration, distillation, extraction, and absorption. Modern control instruments are discussed and operated. One laboratory report per week.

R. F. Hunter and Staff in Chemical Engineering

653. PROCESS MODELLING AND SIMULATION

IV – 6 2 3 – –

The mathematical modelling of steady and unsteady states in typical processes involving fluid flow, heat and mass transfer, vapour-liquid equilibria, and chemical reaction. Solution by analytical, analogue, and digital methods. Introduction to controller response modes.

D. Basmadjian, M. E. Charles, I. H. Spinner

654. ORGANIC CHEMISTRY

IV – 6 2 – 2 –

The Chemistry of the manufacture of natural and synthetic high molecular weight organic materials and the relation between molecular and submicroscopic structure and physical properties of rubbers, fibres, filaments, films and plastics.

W. H. Rapson

655. CHEMICAL ENGINEERING THERMODYNAMICS AND KINETICS

IV – 6 2 – 2 –

The application of thermodynamics and kinetics to problems in the field of chemical engineering.

W. H. Burgess, W. F. Graydon

656. PUBLIC SPEAKING

IV – 6 – – 2 –

Staff in Chemical Engineering

660. ORGANIC CHEMISTRY

IV – 5c 2 – 1 –

A lecture course in organic chemistry, concluding with a section on the chemistry of high polymers.

H. L. Williams

661. ORGANIC CHEMISTRY LABORATORY

IV – 5c – – – 6

A laboratory course to accompany subject 660.

Z. May

662. PROCESS CONTROL

IV – 6 (elective) – – 2 –

Fundamentals to optimal control of engineering systems are developed from the state-space viewpoint. The use of dynamic programming, maximum principle, and other optimization procedures is established and illustrated for both the continuous and discrete time systems. Non-linear analysis is introduced by approximate analytic methods, phase-space representation and the application of some elementary principles of asymptotology. Textbook: *Optimal Control of Engineering Processes* – Lapidus and Luus.

R. Luus

663. INSTRUMENTAL METHODS

IV – 6, 8 (elective) – – 2 –

The subject is designed to emphasize the science of chemical instrumentation. The principles, technique, and applications of gas-chromatographic, opticometric, electrometric, and mass-spectrometric methods of analysis are studied.

S. Sandler

664. PROCESS DYNAMICS

IV – 5c 2 – 2 3

Analysis and control of chemical engineering systems with emphasis on non-linear methods; phase plane; Liapunov's method; averaging technique. Introduction to optimal control of processes; extraction train, distillation column, and chemical reactors.

R. Luus

665. THERMODYNAMICS AND STATISTICAL THERMODYNAMICS OF CHEMICAL SYSTEMS

IV – 5c 3 – – –

Development of the principles of chemical equilibrium and of statistical mechanics; application to both non-reacting and reacting systems, with emphasis on behaviour of multicomponent mixtures and complex reactions, and the calculation of thermodynamic properties in the ideal-gas state. Reference books: *The Principles of Chemical Equilibrium*, by K. G. Denbigh; *Introduction to Statistical Mechanics*, by G. S. Rushbrooke.

R. W. Missen

666. CHEMICAL ENGINEERING DESIGN

IV – 5c 2 6 2 6

Applications of heat transfer and fluid flow, mathematical modelling, and optimization in chemical engineering and chemical plant design. In the first term the laboratory is devoted to problems in these topics and in those of subject 665. In the second term, simultation and optimization are carried out for a particular chemical plant. Reference books: *Applied Mathematics in Chemical Engineering* – Mickley, Sherwood, and Reed. *Chemical Reactor Theory* – Denbigh. *Chemical Reaction Analysis* – Petersen.

J. W. Smith, M. E. Charles, M. Wayman, D. Mackay

667. DYNAMICS OF CHEMICAL SYSTEMS

IV – 5c – – 3 –

Elements of chemical rate process, complex chemical system dynamics, chemical reactor stability. Application of analogue computers to the solution of problems in above topics.

I. H. Spinner

668. APPLIED NUCLEAR CHEMISTRY

IV – 6 (elective) – – 2 –

An introduction to the principles and methods of radioisotope chemistry. Applications of nuclear techniques and radioactive materials in chemical technology and in nuclear power generating systems. Topics to be covered include: radioisotope methods of studying chemical reaction mechanisms and kinetics; chemical process development and process control; nuclear reactions applied to chemical analysis (activation analysis); isotope separation; production of nuclear-grade materials such as uranium, plutonium, heavy water; chemical processing of irradiated reactor fuels; radioactive waste disposal; radiation chemical processing.

R. E. Jervis

669. ADVANCED SEPARATION PROCESSES

IV – 6 (elective) – – 2 –

Theory and application of a number of separation processes, including multicomponent distillation (using computational techniques), azeotropic and extractive distillation, liquid extraction, transient behaviour and cyclic processes, thermal diffusion separations, and solid-liquid contacting operations. Illustrative design problems.

D. Mackay

670. NUCLEAR ENGINEERING

IV – 5nt 2 – 2 –

Nuclear engineering aspects of: nuclear constitution and properties including cross-section, energetics, radioactivity, production and use of radio-isotopes, neutrons, slowing down, "age" theory, diffusion of thermal neutrons, fission. The age and two-group theories of the reactor core. Reflected reactors (elementary treatment). Reactor kinetics, control and instrumentation. Applications of heat transfer, fluid flow and stress analysis to the reactor core. The measurement and control of radiation. Exposure of humans to radiation. Shielding techniques. Nuclear engineering applications of nuclear and radio-chemistry.

J. S. Hewitt, R. E. Jervis

671. NUCLEAR ENGINEERING LABORATORY

IV – 5nt – 3 – 3

A laboratory course to accompany subject 670. Experiments are carried out with radiation sources and instruments, a sub-critical reactor, a reactor simulator, pulse height analyzers, fast neutron generators and radioactive tracers.

J. S. Hewitt, R. E. Jervis

DEPARTMENT OF ELECTRICAL ENGINEERING

700. ELECTRICITY

I – 1, 3, 4, 6, 7, 8, 9 — 2 ¾ 2 ¾

A basic course in electricity and magnetism including electric forces and fields, analysis of direct-current circuits, magnetic forces and fields, induction, and an introduction to the conductive, magnetic and dielectric properties of materials.

Staff in Electrical Engineering

701. ELECTRICITY

I – 5 — 2 – 2 –

A basic course in electricity and magnetism that is similar to subject 700 but adapted to the needs of Course 5.

Staff in Electrical Engineering

710. CIRCUIT THEORY I

II – 7 — 2 2 – –

Linear lumped-parameter circuits as models for physical devices; relationships between circuit and field concepts. Transient response of simple circuits; natural and forced components of response. Response to complex-frequency excitation; impedance and admittance functions. Steady-state response of circuits with direct and sinusoidal sources.

711. ELECTRIC AND MAGNETIC FIELDS

II – 7 — – – 3 2

Static electric and magnetic fields. Properties of dielectric and magnetic media. Particle dynamics in electric and magnetic fields. Time-varying fields. Development of Maxwell's equations and interpretation.

712. CIRCUIT THEORY II

II – 7 — – – 3 2

Loop and nodal analysis. General network theorems. Coupled circuits. Response of networks to variable-frequency excitation. Analysis of polyphase circuits; introduction to symmetrical components.

713. ELECTRICAL LABORATORY

II – 7 — – 3 – –

Introduction to techniques of electrical measurement. Laboratory experiments to accompany subjects 710 and 711.

714. INTRODUCTORY ELECTRONICS

II – 7 — – – 2 3

The broad application of semiconductor devices to common engineering systems; basic device characterization, modelling, amplification, waveshaping, switching.

715. ELECTRIC CIRCUITS

II – 5 2 – 2 –

Circuits as models for physical devices. Kirchhoff's laws. Transient response of circuits. Steady-state response of circuits with sinusoidal excitation. Network theorems. Topology and loop and nodal analysis of general circuits. Complex frequency analysis of circuits. Response of circuits to variable-frequency excitation. Analysis of polyphase circuits. Magnetically coupled circuits.

716. ELECTRIC CIRCUITS LABORATORY

II – 5 – 1½ – 1½

Laboratory exercises to accompany subject 715.

717. CIRCUIT THEORY

II – 3 2 1½ – –

Introduction to linear circuit analysis. Phasor representation and the analysis of alternating-current circuits in the steady state. Magnetic circuits and transformers.

718. ELECTRICAL MEASUREMENTS

II – 3 – – 2 1½

Transducers for electrical measurement of non-electrical variables, and associated instrumentation. Errors. Analogue computation. Digital logic.

719. ELECTRICAL ENGINEERING

II – 4, 6, 8 2 – 2 –

Analysis of single-phase and three-phase circuits; principles of a-c and d-c machines; introduction to vacuum-tube and solid-state devices; basis of digital computation and analogue simulation; electronic measurements applied to industrial processes.

720. ELECTRICAL LABORATORY

II – 4, 6, 8 – 3 – 3

Laboratory experiments and problems to accompany subject 719.

721. NUMERICAL METHODS

II – 7 – – 2 2

Elementary numerical methods for systems of equations, iteration, integration, differential equations, roots, and random number generation, including a study of roundoff and truncation error. Basic computer structure and organization. Algorithms, procedures, and flowcharts. Discrete simulators and continuous simulators.

730. PHYSICAL ELECTRONICS I

III – 7 2 1½ – –

The prime objective of 730 and 731 is to provide a sound physical understanding of phenomena and devices in modern electronics. Circuit models of devices are developed from the mathematical models which describe the basic device physics. Band theory of solids: Fermi-Dirac statistics. Metals, semiconductors and insulators: thermionic emission, Schottky effect and high field emission with examples. Contact potentials. Semiconductor theory: band structure of Ge, Si and III-V compound semiconductors. Intrinsic and extrinsic semiconductors: general calculation of the Fermi level, hole and electron densities. Mobility, conductivity and their temperature dependence. Diffusion. The continuity equation and its solution. Theory of p-n junctions; minority carrier injection, basic equations. Depletion and diffusion capacitances. Circuit models. Other diode structures: tunnel diodes, Schottky barrier diodes, Gunn diode.

731. PHYSICAL ELECTRONICS II

III – 7 – – 2 1½

Unipolar transistors: basic types: junction-gate, M.I.S., and thin-film F.E.T.'s theory, circuit models. Bipolar transistors: fundamental theory, injection efficiency, base transport efficiency, small-signal low-frequency models. Charge storage models. High-frequency, small-signal analysis and circuit models. Fundamentals of integrated circuits: fabrication theory and technology: diffusion, epitaxy, oxide masking: capacitors, resistors, bipolar and unipolar transistor integration. Examples. Photoelectronics solid-state optoelectronic phenomena: photoconductive, photovoltaic and p-n junction radiation detection. Vacuum photoelectronics: image orthicon, vidicon, image storage and intensification.

732. APPLIED MATHEMATICS I

III – 7 2 2 – –

Theory of functions of complex variables, with applications.

733. LINEAR SYSTEMS THEORY

III – 7 4 2 – –

Correlation with orthogonal functions as a method of signal transformation. Fourier series, generalized Fourier and bilateral Laplace transforms; existence, uniqueness, and properties. Time-domain analysis; weighting functions, convolution, convolution algebra, similarity of correlation and convolution. Frequency-domain analysis; transfer functions, filter characteristics, pole-zero configurations. Frequency-domain convolution; time-varying systems and modulation. Matrix methods for multiple input-output systems; theory of linear two-port networks.

734. ELECTROMECHANICAL SYSTEMS I

III – 7 2 3 – –

Processes of electromechanical energy conversion; modelling and analysis of magnetic devices and systems; transformers and saturable reactors; commutator machines.

735. ELECTROMECHANICAL SYSTEMS II

III – 7 – – 2 3

Generalized polyphase machines; induction and synchronous machines; introduction to the control of electric machine systems.

736. APPLIED MATHEMATICS II

III – 7 – – 3 2

Introduction to Modern Algebra. Elementary theory of probability and stochastic processes.

and electron densities. Mobility, conductivity and their temperature dependance. Dif-

737. ELECTRONIC CIRCUITS I

III – 7 – – 2 3

P-N junction diode models: advanced applications of p-n junction diodes. Temperature dependence of diode characteristics and methods for compensation. Amplifiers, specifications, general methods of design. Field-effect transistors: characteristics, biasing, amplifiers, voltage controlled resistance. Bipolar transistors: basic concepts, fabrication: power gain: basic configurations: Ebers and Moll model: circuit models: single and multistage amplifiers. Switching properties; feedback amplifiers: oscillators. Narrow and wide band amplifiers. Power amplifiers. Integrated circuit design techniques.

738. ELECTRONICS LABORATORY

III – 5a, 5cs, 5e, 5p – – – 3

Laboratory experiments to accompany subjects 730, 737 and 739.

739. PHYSICAL ELECTRONICS

III – 5a, 5cs, 5e, 5p 2 – 2 –

A subject similar in content of that of 730 but adapted to the needs of Course 5.

740. ELECTRONICS

III – 5c, 5g 2 – 2 –

Qualitative treatment of the physical principles of electron devices; analysis of idealized and basic practical rectifying and power-modulating circuits; some applications to systems.

741. ELECTRONICS LABORATORY

III – 5c, 5g – – – 1½

Laboratory experiments to accompany subject 740.

742. CIRCUIT ANALYSIS

III – 5cs, 5e, 5p 2 – 2 –

Advanced analytical methods are used to derive general network theorems and to discuss general network properties. Complex wave forms, filters and unbalanced polyphase networks are considered in detail.

743. ELECTRONICS

III – 3 2 3 – –

Principles of electronics. Linear models of electronic devices. Amplifiers, oscillation and filters. Electronic circuits.

747. ELECTRICAL MACHINES

III – 3 – – 2 3

Principles of energy conversion. Transient operation of electromechanical systems. Electromechanical circuits. Rotating machinery.

750. FIELDS AND WAVES

III – 7 2 2 – –

Transient and steady-state analysis of transmission lines. Plane waves. Parallel-plate waveguide. Radiation from a current element.

751. THERMODYNAMICS AND STATISTICAL MECHANICS

II – 7 – – 3 1

III – 7 (1969 – 70 only) – – 3 1

The fundmental principles of thermodynamics and statistical mechanics; Boltzmann, Fermi-Dirac and Bore-Einstein distributions and their applications to electric, magnetic and electromagnetic systems; elementary theory of fluctuations.

754. ELECTROMAGNETIC FIELDS

III – 5e, 5p 1 1 1 1

Transmission lines; static and quasi-static fields; applications of Maxwell's equations; plane waves, waveguides.

760. SWITCHING THEORY

IV – 5cs, 7 (elective) 2 1 – –

Boolean algebra, boolean functions, combinational networks, minimum complexity combinational networks, Karnaugh and Quine-McCluskey minimization. Sequential machines state assignment, state reduction, relationship to switching components. The problems period will provide exercises in logic and sequential machine analysis and synthesis. Text: P. E. Wood – *Switching Theory*.

761. INFORMATION PROCESSING SYSTEMS I

IV – 5, 7 (elective) 2 1 – –

Number representation: Binary number system, representation of negative numbers, binary arithmetic. Computer architecture: basic hardware structure, registers, memory system, addressing, instructions, 1/0. Programming languages; machine language programming, basic and macro assemblers, compilers. (PL/1, Algol. simulators). Programming systems: data structures, properties of data types, syntax structures, parsing, symbol tables. The problems period will include exercises in programming in 360 assembly language and in a variety of high level languages.

762. ELECTROMAGNETIC THEORY

IV – 7 (elective) 2 1 – –

Waveguides. Antennas. Field solutions in conducting media. Wave theory of optics.

763. UNIFIED MACHINE THEORY

IV – 7 (elective) – – 2 1½

The theory of linear passive power invariant transformations is developed. Electromagnetic devices will be presented by flux linkage models which are then modified by various generalized transformations in order to facilitate their representation in systems requiring transient and steady state stability studies. A generalized co-ordinate transformation system for an m-n phase system revolving with respect to any arbitrary reference frame is developed and this is then reduced to the more classical phase, dq, or symmetrical component models. Evaluation of system parameters required for the models will be discussed.

765. CONTROL SYSTEMS I

IV – 7 3 1½ – –

Open-loop and closed-loop control; feedback systems. Flow-graph analysis of complex systems. Steady-state performance analysis. Stability analysis for linear time-invariant systems; algebraic, real-frequency, and root-locus methods. Design of single input-output controls. Elementary nonlinear analysis.

766. SYSTEM DYNAMICS

IV – 5a, 5e 2 – 2 –

A study of the dynamic behaviour of systems, using the techniques of state representation, Laplace and Z transforms, frequency-response and root-locus methods. Introduction to feedback control systems. Stability and compensation of linear and nonlinear control systems. Introduction to optimal control.

768. ELECTRONIC CIRCUITS II

IV – 7 2 3 – –

Design of semiconductor circuits emphasizing bias stabilization, feedback d-c amplifiers, broadband amplifiers, tuned amplifiers and large signal applications.

769. ELECTRONIC CIRCUITS LABORATORY

IV – 5a, 5cs, 5e, 5p – – – 3

Experiments and problems to accompany subject 778.

770. COMMUNICATION SYSTEMS

IV – 7 (elective) – – 2 3

An introduction to the analysis and design of systems for transmitting information.

772. NETWORK THEORY

IV – 7 (elective) 2 1 – –

The basis of network analysis; differential equations, s-plane representation, steady state, transient, transfer functions, two-port parameters, insertion loss, the synthesis problem. The positive-real concept of Brune; positive-real testing, stability testing, synthesis of RLC one-terminal pairs (Brune), reactance functions. Two-port synthesis, positive real matrix, residue condition, symmetric lattice, ladder network synthesis (single and double termination).

773. SYSTEMS DYNAMICS LABORATORY

IV – 5a, 5e – 1½ – 1½

Laboratory experiments and problems to accompany subject 766.

774. INTEGRATED CIRCUITS

IV – 7 (elective) – – 2 1½

Introduction to integrated circuits. Semiconductor statistics. Non-equilibrium processes in semiconductor surfaces. Processes involved in fabrication of integrated semiconductor devices and thin film circuits. Capacitors, resistors and inductors in integrated circuits. Diode and transistor design. Linear and digital integrated circuit design techniques.

775. SOLID STATE PHYSICS FOR ENGINEERS

IV – 7 (elective) 2 1½ – –

Crystal structure and crystal binding. Elastic waves. Phonons and Lattice Vibrations. Thermal properties of insulators. Free-electron theory. Semiconductor crystals. Dielectric properties. Magnetism.

776. RADIATION AND PROPAGATION

IV – 7 (elective) (prerequisite – 762) – – 2 1½

Antenna arrays. Aperture antennas. Noise properties of antennas. Terrestrial wave propagation.

777. QUANTUM PHYSICS

IV – 7 (elective) 2 1½ – –

Development of Schroedinger equation and its use for simple models. Electron theory of atomic structure and applications.

778. ELECTRONIC CIRCUITS

IV – 5a, 5cs, 5e, 5p 2 – 1 –

A course similar to subject 768 but adapted to the needs of Course 5.

779. POWER SYSTEMS ANALYSIS

IV – 7 (elective) 2 1½ – –

Engineering criteria for generation, transmission and distribution of electrical energy in bulk. Characteristics of components and their significance to power system safety, reliability and economy. Behaviour of elementary power systems under normal and fault conditions.

780. POWER SYSTEMS CONTROL

IV – 7 (elective) – – 2 1½

Economic management of electric power system operation. Methods for determination of load flows. Economic scheduling of generating plants. Basic concepts of load frequency control. Analysis of power system dynamical performance including the effects of generator controls.

781. APPLIED MATHEMATICS III

IV – 7 (elective) 2 1 – –

Partial differential equations and the calculus of variations.

782. INFORMATION SYSTEMS I

IV – 5cs, 5e 2 – 1 –

The analysis and design of information systems and components, noise, information and signal theory.

783. INFORMATION SYSTEMS LABORATORY

IV – 5e – – – 3

Experiments and problems to accompany subjects 782 and 786.

S. Dmitroevsky

784. QUANTUM ELECTRONICS

IV – 7 (elective) (Prerequisite – 777) – – 2 1

Theory of radiation absorption and emission; susceptability, population inversion and maser action. Maser and laser materials and device properties, limitations and use of the devices; nonlinear behaviour of materials at optical frequencies.

786. INFORMATION SYSTEMS II

IV – 5e – – 2 –

The study of digital information processing including the coding of data, and the design of logic circuits and switching systems.

787. TECHNIQUES OF OPTIMIZATION

IV – 5cs 2 3 2 3

Linear and non-linear mathematical programming; dynamic programming; queueing theory; some problems in control theory; Monte Carlo methods. Applications will be drawn from engineering practice.

788. ENERGY CONVERSION PROCESSES

IV – 5e 2 – 2 –

Energy conversion phenomena, magnetic materials, modelling and analysis of magnetic devices including transformers, commutator and polyphase machines, solid-state converters. Electro-magnetic force and fluid interactions.

789. ENERGY CONVERSION LABORATORY

IV – 5e – 1½ – 1½

Investigations and projects related to subject 788.

790. WAVE THEORY

IV – 5e, 5p 2 – 2 –

Mechanical and electromagnetic waves in one dimension for transient and steady state conditions. Guided waves. Radiation. Interaction of waves with matter.

791. WAVE LABORATORY

IV – 5e – 3 – –

Supplementing course 790.

792. ACOUSTICS

IV – 7 (elective) – – 2 1½

The properties of acoustical elements and their application in electrical sound systems.

V. L. Henderson

793. CONTROL SYSTEMS II

IV – 7 (elective) – – 2 1

State representation of dynamic systems. Vector-matrix differential and difference equations as descriptions of linear systems. Eigenvalues, eigenvectors, and transition matrices. Controllability and observability. Introduction to optimization. Emphasis throughout on the use of analog and digital computers as aids to analysis and synthesis.

794. ILLUMINATION

IV – 7 (elective) – – 2 1½

Nature, measurement and production of light and related radiations. Theory of human vision; consideration of environmental design requirements related to light and vision for optimum visual efficiency and comfort.

Miss M. G. Currie

795. POWER SEMICONDUCTOR CIRCUITS

IV – 7 (elective) – – 2 1½

Principles of thyristor devices. Study of inverter, converter and rectifier circuits with particular applications to DC and AC motor speed control and frequency conversion.

796. BIOMEDICAL ENGINEERING

IV – 7 (elective) – – 2 1½

Interaction between engineering and medicine; biological examples of important engineering concepts; instrumentation.

797. ELECTRODYNAMICS

IV – 7 (elective) (Prerequisite – 762) – – 2 1

Interaction of charged particles with electromagnetic fields. Electromagnetic properties of materials. Interaction between electromagnetic fields and fluids. Special relativity.

798. INFORMATION PROCESSING SYSTEMS II

IV – 5, 7 (elective) (Prerequisite – 761) – – 2 1

Computer organization: register implementations, register transfers, memory, control unit logic, instruction processing logic, execution unit, simple implementations of arithmetic operations. Programming languages; some advanced concepts of applications and systems programming in both business and scientific areas. Formal languages and machines: finite state language and automata, formal grammars, context free languages and their relation to programming languages, Turing machines. The laboratory session will include problems in 360 assembly language programming based on the course.

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

801. PHYSICAL CHEMISTRY

II – 8 2 2 2 2

A course on basic physico-chemical properties of matter with emphasis on kinetic theory of gases, phase relationships and transformations.

S. N. Flengas, J. M. Toguri

802. CHEMICAL METALLURGY

III – 8 – – 2 –

A fundamental treatment of the metallurgical processes involved in the production of the important non-ferrous metals, including oxidation of sulphides in the liquid and solid states, reduction of oxides, matte-slag equilibrium, metal-slag equilibrium, and the distillation of metals.

L. M. Pidgeon, J. M. Toguri

803. CHEMICAL METALLURGY LABORATORY

III – 8 – 3 – 6

Experiments in materials processing, including roasting, smelting, leaching, refining, electrolysis to accompany subjects 802 and 833. Eight laboratory reports per term.

H. U. Ross

804. EXTRACTIVE METALLURGY

III – 9 2 – 2 –

The metallurgical processes involved in the beneficiation of ores and the extraction of metals therefrom and their subsequent refinement.

L. M. Pidgeon, H. U. Ross

805. CHEMICAL METALLURGY

IV – 8 2 – 2 –

The extractive metallurgy of iron, steel, and the reactive metals.

L. M. Pidgeon, H. U. Ross, J. M. Toguri

806. CHEMICAL METALLURGY LABORATORY

IV – 8 – 6 – –

Experiments in the extraction and refining of metals and related processes to accompany subject 805. Six laboratory reports per term.

S. N. Flengas, H. U. Ross, J. M. Toguri

808. METALLURGICAL ANALYSIS

II – 8 – – – 3

Quantitative analysis of the common metals in ores, concentrates, mattes, slags and alloys.

H. U. Ross

810. THERMODYNAMICS IN METALLURGY

III – 8 2 – 2 –

A study of chemical equilibria at high temperatures in extractive metallurgy – slag metal reactions – classical theory of solutions – phase transformations – thermodynamic relationships in phase diagrams.

S. N. Flengas

812. METALLURGICAL PROBLEMS LABORATORY

III – 8 – 4 – 4

Problems in chemistry, physical chemistry and thermodynamics as applied to metallurgical processes, and solid state reactions relating to subjects 802 and 810.

S. N. Flengas, H. U. Ross

813. ELECTROCHEMICAL PROCESSES

IV – 8 – – 2 2

Electrochemistry of solids, liquids, and of high temperature systems. Fused salt electrochemical cells. Thermodynamics of imperfections and properties of ionic solids.

S. N. Flengas

814. METALLURGICAL PROBLEMS LABORATORY

IV – 8 – 4 – 4

Problems relating to subjects 805 and 823.

Staff in Metallurgy and Materials Science

815. MATERIALS SCIENCE

IV – 8 2 – 2 –

Application of thermodynamics and kinetics to solid state transformations, plastic deformation and other problems in materials; electrical, thermal and magnetic properties of materials.

U. F. Franklin, B. Ramaswami

816. PRINCIPLES OF METALLOGRAPHY

II – 8 1 3 – –

A discussion of the framework of metallographic practice, dealing with optical, x-ray, electron and field-ion microscopy applied to a wide range of materials. Topics covered include the optics of microscopy and diffraction; the use of polarized light, phase contrast and interferometry; specimen preparation methods; applications of quantitative metallography.

W. A. Miller, G. C. Weatherly

819. MATERIALS SCIENCE I

II – 7 3 1½ – –

The thermal, mechanical and chemical properties of materials will be related to their microscopic structure. Atomic bonding, crystal structure (with special emphasis on Group IV and Group III–V semiconductors): Thermodynamics of solids, defects. Solid-state diffusion. Phase diagrams, phase transformations with examples. Single crystal growth. Mechanical properties: stress, strain and shear relations for isotropic and anisotropic materials; annealing, structural materials; fabrication processing. Corrosion.

821. PHYSICS OF METALS

III – 5m, 8 2 – 2 –

Structure of solids; solidification and casting; growth of single crystals; zone refining;

diffusion; solid state phase transformations; imperfections in crystals; plastic deformation; physical and mechanical properties of solids.

G. B. Craig, J. W. Rutter

822. PHYSICS OF METALS LABORATORY

III – 5m, 8 – 6 – 3

An introductory series of experiments dealing with annealing and recrystallization, plastic deformation and mechanical properties, and the use of metallographic, x-ray and non-destructive testing methods. The remainder of the schedule is devoted to metallurgical projects chosen by the students and carried out in close consultation with the staff.

823. PHYSICS OF METALS

IV – 8 2 – 2 –

Structures and properties of interfaces; recovery and recrystallization; annealing textures and anisotropic properties; martensitic transformations; structures and properties of ferrous, non-ferrous and nuclear materials.

K. T. Aust, G. B. Craig

824. PHYSICS OF METALS LABORATORY

IV – 8 – 3 – 3

Practical work relating to subject 823.

G. B. Craig, G. C. Weatherly

826. MATERIALS SCIENCE SEMINAR

IV – 8 – 3 – 3

Each student prepares and presents seminars on topics concerning chemistry and physics of materials.

Staff in Metallurgy and Materials Science

827. MATERIALS SCIENCE LABORATORY

IV – 5m – 12 – 12

The design and execution of one or more experiments on a topic of current interest in the field of chemistry and physics of materials.

Staff in Metallurgy and Materials Science

830. METALLURGICAL THERMODYNAMICS

III – 5m 2 – 2 –

A study of chemical equilibria at high temperatures in metallurgy; slag metal reactions; chemical theory of solutions; alloys; phase transformations; thermodynamic relationships in phase diagrams; statistical concept of entropy; simple partition functions; quasichemical approach to the theory of solutions; methods of investigating thermodynamic properties.

S. N. Flengas

831. METALLURGICAL THERMODYNAMICS PROBLEMS

III – 5m – 2 – 2

Problems relating to subject 830.

S. N. Flengas

832s. MATERIALS SCIENCE

II – 8 2 – 2 –

A course on the structure and properties of plastics, glass, ceramics, semi-conductors, and concrete.

Staff in Chemical Engineering, Civil Engineering, Electrical Engineering, Metallurgy and Materials Science

833. MATERIALS PROCESSING

III – 8 3 – – –

The theory and practice of processing metallic and non-metallic materials, including the relevant aspects of mineralogy, surface chemistry, physical separation, calcining, roasting, sintering and leaching.

H. U. Ross

834. MATERIALS SCIENCE

II – 4 2 – 2 3

A discussion of the effects of microscopic and atomic structures on the electrical, chemical and mechanical properties of engineering materials. The topics covered include atomic bonding, structures of ideal and real crystals, phase transformations and diffusion, chemical and mechanical properties, and oxidation and corrosion phenomena. The laboratory experiments will include x-ray studies of crystal structure; measurement of resistivity and magnetism of selected solids; study of various alloy phases and transformations; study of dislocation patterns, stress-strain relationships, stress-relaxation and fatigue phenomena; study of oxidation and corrosion reactions.

G. B. Craig, B. Ramaswami

835. MATERIALS SCIENCE II

III – 7 – – 2 1½

The magnetic, dielectric and conductive properties of materials, as related to their structure, will be discussed. Magnetic properties: dia-, para-, ferro-, antiferro-, and ferri-magnetic phenomena; magnetic domains and domain wall motion; "hard" and "soft" magnetic materials; magneto-striction. Dielectric materials: insulating properties; conduction mechanism; dielectric loss. Ferroelectric materials. Electrical conduction: temperature dependence; effect of composition and structure on conductivity. Thermoelectric phenomena.

U. M. Franklin

836. REACTION KINETICS

IV – 8 2 2 – –

Kinetics of heterogeneous reactions. Diffusion controlled processes. Imperfections in

solids. Fick's laws of diffusion. Application of theory to metallurgical operations.

J. M. Toguri

837. MATERIALS SCIENCE

II – 3 2 – 2 1½

A discussion of the effects of microscopic and atomic structures on the properties of engineering materials. The topics covered include atomic bonding and structures of materials, diffusion, crystal growth and solidification, plastic deformation and annealing, precipitation hardening, phase transformations especially in ferrous materials, relationships between structures and mechanical properties of metallic and non-metallic materials, and composite materials.

The laboratory experiments are designed to illustrate the principles underlying the relationship between structures and properties of engineering materials.

K. T. Aust and W. A. Miller

838. MATERIALS SCIENCE

III – 5m – – 2 –

A course on the structures and properties of materials, particularly non-metallic inorganic solids.

Staff in Metallurgy and Materials Science

839. MATERIALS SCIENCE

IV – 5m 2 3 2 3

A continuation of course 838 with emphasis on physical and mechanical properties of materials; high-purity and composite materials. The laboratory work deals with experimental studies of the relationship between structures and properties of materials. Application of x-ray, electron microscopy, electron diffraction, electron microbeam techniques to the study of materials.

Staff in Metallurgy and Materials Science

840. HIGH TEMPERATURE PHYSICAL CHEMISTRY

IV – 5m 2 2 2 2

Properties of solids and liquids at high temperatures; thermodynamics of defects; solid oxide electrolytes; mechanism of electrical conductivity in ceramic phases; fused-salt electrolytes; reactions in fused-salt media; electrochemical cells at high temperatures; fuel cells; structural properties of simple and complex liquid phases; electrochemical corrosion and passivation; kinetics of heterogeneous reactions.

S. N. Flengas

841. THEORY OF METALLURGICAL REACTIONS

IV – 5m 2 – – –

Metal extraction and refining processes are examined in terms of chemical thermodynamics and kinetics. The principles and methods of extraction of ferrous and nonferrous metals, roasting, leaching and electrowinning are typical of the subjects discussed.

J. M. Toguri

INSTITUTE FOR AEROSPACE STUDIES

1028. FLUID MECHANICS

III– 5a 2 – 1 –

Introductory concepts and idealizations of real fluids; mathematical theory of incompressible inviscid flow; viscous flow and turbulence. Reference books: *Fundamentals of Hydro and Aeromechanics* – Prandtl and Tietjens; *Applied Hydro and Aeromechanics* – Prandtl and Tietjens; *Fluid Dynamics* (1948 ed.) – Streeter. Advanced reading: *Hydrodynamics* – Lamb; *Incompressible Aerodynamics* – Thwaites.

H. S. Ribner

1029. FLUID MECHANICS LABORATORY

III– 5a – 3 – 1½

Problems and experiments related to subject 1028. Seven laboratory reports.

H. S. Ribner, P. A. Sullivan

1030. ADVANCED MECHANICS

III – 5a, 5e, 5g, 5m, 5nt, 5p 2 – 2 –

Mechanics of particles: fixed axes, rotating and moving axes, orbital dynamics, rockets. Mechanics of rigid bodies: fixed axes, body-attached axes, gyroscopes. Mechanics of linear systems: free and forced oscillations, coupled systems, waves on a string. Rayleigh's method. Lagrange's equations. Introduction to special relativity. Reference books: *Principles of Dynamics* – D. T. Greenwood. *Principles of Mechanics* – Synge and Griffith. *Dynamics*, Vols. I and II, Halfman.

S. J. Townsend

1034. MECHANICS OF STRUCTURES

III – 5a 2 – 2 –

Basic theorems and principles in the theory of structures (strain energy, virtual displacements, minimum total potential energy). General theory of bending of beams (unsymmetrical bending, thin walled structures, shear flow in multiflanged beams, open and closed sections). General theory of torsion (thin walled structures, multi-cell structures, shear centre). Theory of elastic instability (buckling of slender elastic struts, flat and curved plates, shells). Plane stress problems (Airy and Prandtl stress functions).

R. C. Tennyson

1035. MECHANICS OF STRUCTURES LABORATORY

III – 5a – 1½ – 3

Problems and experiments relating to subject 1034. Five laboratory reports.

R. C. Tennyson

1040. AERODYNAMICS

IV – 5a 2 – 2 –

Aerodynamics of flight: drag, propulsion, wing theory. Mechanics of flight: performance of aircraft, stability and control of aircraft. Reference books: *Aerodynamics*

of V/STOL Flight – B. W. McCormick, Jr. *Foundations of Aerodynamics* – Kuethe and Schetzer. *Flight Mechanics – 1: Theory of Flight Paths* – A. Miele. *Dynamics of Flight – Stability and Control* – Etkin.

L. D. Reid

1041. AERODYNAMICS LABORATORY

IV – 5a – 1½ – 1½

Problems and experiments related to subject 1040. Six laboratory reports.

L. D. Reid

1042. PHYSICS OF RADIATING GASES

IV – 5a 2 – 2 –

Review of atomic and spectroscopic theory, line radiation, Einstein coefficients, optical depth, population inversion and lasers, Doppler and pressure broadening, vibration and rotation of molecules, local thermodynamic equilibrium, methods, of determining the temperature and electron number density of high temperature gases.

R. M. Measures

1043. PHYSICS OF RADIATING GASES LABORATORY

IV – 5a – 1½ – 1½

Probe and spectroscopic studies of a low pressure discharge. Three laboratory reports.

R. M. Measures

1044. PHYSICS AND MECHANICS OF SOLIDS

IV – 5a 2 – 2 –

Properties of solids, the factors on which they depend. Structural imperfections, atom movements, dislocation theory. Deformation and failure of metals. Metal fatigue, service loads and service load laboratory simulation, statistical evaluation of fatigue data. Microstructural changes in metal due to fatigue, fatigue damage accumulation, crack initiation and propagation. Environmental effects on service life under fatigue, surface protection. Reference books: *Elements of Materials Science* – Van Vlack. *Inelastic Behaviour of Engineering Materials and Structures* – Freudenthal.

G. K. Korbacher

1045. PHYSICS AND MECHANICS OF SOLIDS LABORATORY

IV – 5a – 1½ – 3

Problems and experiments related to subject 1044. Six laboratory reports.

G. K. Korbacher

1046. PLASMADYNAMICS

IV – 5a 2 – 2 –

Electrostatics, magnetostatics, Maxwell's equations, E-M wave propagation, plasma equations of motion and conduction, MHD approximation, tensor conductivity, Alfvén, magnetoacoustic and MHD shock waves, simple flow problems in magnetogasdynamics, applications to propulsion and power generation. Reference books:

Engineering Magnetohydrodynamics – Sutton and Sherman. *The electromagnetogasdynamics of Fluids* – Hughes and Young. *Magnetofluidmechanics* – Cambel.

S. J. Townsend

1047. ENGINEERING DESIGN

IV – 5a – 6 – 3

A number of multidisciplinary engineering design projects are carried out by the student under the supervision of staff and of experienced design engineers from industry. Drawings and reports are prepared as required.

G. K. Korbacher

1048. GASDYNAMICS

IV – 5a 2 – 2 –

The fundamental phenomena that occur in a flow of a compressible fluid are treated. The basic thermodynamics is reviewed and the equations of viscous and inviscid compressible flow are derived. Compressible flow in nozzles and diffusers, and shock and expansion waves in both steady and unsteady flow; and high temperature effects which cause departures from the perfect gas law are discussed. Applications relevant to modern high speed flight are given. Reference books: *Elements of Gasdynamics* – Liepmann and Roshko. *Dynamics and thermodynamics of Compressible Fluid Flow* – Shapiro. *Handbook of Supersonic Aerodynamics, Section 18, Shock Tubes* – Glass and Hall. *Introduction to Physical Gasdynamics* – Vincenti and Kruger.

P. A. Sullivan

1049. GASDYNAMICS LABORATORY

IV – 5a – 1½ – 3

Problems and experiments based on subject 1048 are given to illustrate principles of gasdynamics and the measurement of physical quantities. Six laboratory reports.

P. A. Sullivan

1050. TRANSPORT PHENOMENA

IV – 5a – – 2 –

A fundamental treatment of selected phenomena in fluid dynamics in which the transport of momentum, mass and energy are the key underlying processes, i.e. dynamics of viscous fluids; boundary layers; diffusion. Reference book: *Transport Phenomena* – Bird, Stewart and Lightfoot.

J. B. French

DEPARTMENT OF PHILOSOPHY

2040. PHILOSOPHY AND SCIENCE

IV – All courses 2 – – –

The relation between Science and Philosophy; and examination of the presuppositions of science and its basic concepts; alternative accounts of the implications of science for social, moral, and religious conceptions.

P. M. Churchland

DEPARTMENT OF ENGLISH

2110. ENGLISH

I – All courses 2 – 2 –

A course in essay writing and the reading of literary works. Texts will include: Twain, *Huckleberry Finn* (Riverside or Chandler); Camus, *The Stranger* (Vintage); Warren and Erskine (eds.), *Short Story Masterpieces* (Dell); Shakespeare, *Antony and Cleopatra* (Arden); one other novel, two other plays, and a poetry anthology to be announced in September. Another novel and play may be added at the discretion of the instructor. Students must complete satisfactorily all assignments, including class tests, given them by their instructor. It should be noted that the final mark for the year is the average of the term mark and the examination mark.

2140. ENGLISH LITERATURE

IV – All courses 1 – 1 –

A course in drama, fiction, and poetry. Texts will include: Brecht, *Galileo* (Methuen); Williams, *A Streetcar Named Desire* (Signet); Miller, *The Crucible* (Bantam); Golding, *The Lord of the Flies* (Penguin); Heller, *Catch – 22* (Dell); Cary, *The Horse's Mouth* (Penguin). Students are expected to read the works named above during the summer preceding their entry into the Fourth Year. One other play, a collection of short stories, and a poetry selection will be announced in September. Term work will include a class test on the summer reading to be given in the second lecture period of the year, one substantial essay, and one or two further class tests at the discretion of the instructor.

DEPARTMENT OF HISTORY

2330. THE HISTORY OF TECHNOLOGY AND ENGINEERING

III – All courses (elective) 2 – 2 –

An historical treatment of the development of tools, techniques, and relevant skills from their inception processes will be considered along with the interplay with contemporary society. Historical points of contact with theoretical and scientific thought will be examined. The accomplishments, influence, and role of the engineer will be traced from antiquity to current society.

J. W. Abrams

2332. EUROPE AND THE MODERN WORLD, 1500–1950

III – All courses (elective) 2 – 2 –

An introduction to the main currents of European history between 1500 and 1950, and of European relations with the extra-European world. The purpose of the course is not merely the accumulation of factual information, but also the attainment of some understanding of historical processes affecting the forms of political organization, economic activity, intellectual and social movements. Textbook: E. R. Tannenbaum, *European Civilization Since The Middle Ages* (John Wiley).

J. Dent

DEPARTMENT OF MATHEMATICS

2410s. ALGEBRA AND ANALYTIC GEOMETRY

I – 1, 3, 4, 6, 7, 8, 9 — 2 1 2 1

Vectors, linear algebra, matrices, solution of linear systems of equations, linear transformations, eigenvalues, linear programming, complex numbers, quadrics.

Staff in Mathematics and Staff in Engineering

2411s. CALCULUS

I – 1, 3, 4, 6, 7, 8, 9 — 2 1 2 1

Limits; derivatives, integrals and their properties with applications; circular and exponential functions and their inverses; differential equations.

Staff in Mathematics and Staff in Engineering

2415s. ALGEBRA AND GEOMETRY

I – 5 — 2 1½ 2 1½

Complex numbers and fields. Polynomials. Linear Algebra: linear equations, vector spaces and linear transformations. Co-ordinate Geometry: lines, planes and surfaces of the second degree.

B. Etkin, L. T. Gardner

2416. CALCULUS

I – 5 — 2 1½ 2 1½

An introduction to the theory and applications of differential and integral calculus. Reference book: *Calculus*, Vol. I – Apostol.

P. Rosenthal, D. K. Sen

2420s. CALCULUS

II – 1, 3, 4, 6, 8, 9 — 2 1 2 1

Continuation of subject 2410. Partial differentiation, multiple integration, series and Taylor's theorem, complex numbers and hyperbolic functions, first order differential equations and higher order linear differential equations with constant coefficients.

M. A. Akcoglu, K. Murasugi, E. Prugovecki, R. Van Luus

2421. CALCULUS AND DIFFERENTIAL EQUATIONS

II – 7 — 2 2 2 2

The definite integral, expansion in series, ordinary differential equations, partial differentiation, multiple integration and an introduction to partial differential equations.

D. Masson

2422. PROBABILITY AND STATISTICS

II – 3 2 1 – –

Probability Concepts: Independent and conditional events, discrete and continuous frequency distributions, moments and generating functions. Sampling: randomness, samples from populations, central limit theorem, transformation of variables, levels of significance. Tests of hypotheses.

W. Haque

2423. PROBABILITY AND STATISTICS

II – 4, 8 2 2 2 2

Frequency distributions and probability laws; binomial, Poisson, and normal distributions and the treatment of samples drawn from them; tests of significance and confidence limits; control charts; introduction to the analysis of variance; design of experiments; regression theory.

A. E. Paull

2425. CALCULUS

II – 5 3 2 3 2

Ordinary and partial differentiation, differentials. Taylor's theorem for functions of one or more variables, maxima and minima, transformations, convergence and uniform convergence, differential equations of the first order, linear differential equations with constant coefficients, methods of indefinite integration, definite integrals, multiple integrals, line and surface integrals, orthogonal functions. Textbook: *Advanced Calculus* – Taylor.

W. J. Webber

2427. PROBABILITY AND STATISTICS

II – 5 – – 3 2

Definition of probability; binomial, Poisson, and normal distributions; frequency; sampling distributions. Examples of estimation, hypothesis testing, control charts, regression, and analysis of variance.

W. K. Hastings

2429. NUMERICAL METHODS

II – 5 3 2 – –

Non-linear equations, matrix calculations, quadrature, and ordinary differential equations.

E. V. Swenson

2430. PROBABILITY AND STATISTICS

III – 4 1 1½ 1 1½

A continuation of course 2423. General regression theory; elements of the theory of sample surveys; an introduction to the theory of stochastic processes.

R. Wormleighton

2432. DIFFERENTIAL EQUATIONS

III – 4, 8, 9 2 1½ 2 1½

First and second order ordinary differential equations, operational methods, variation of parameters, solution in series, Fourier series, Bessel and Legendre functions, the Laplace transform.

W. A. Coppel

2433. NUMERICAL ANALYSIS

III – 4 2 1½ 2 1½

Solution of algebraic equations, systems of linear equations, eigenvalue problems, interpolation, approximation theory, numerical integration, random numbers. Textbook: *Elementary Numerical Analysis* – S. D. Conte. Reference: *Modern Computing Methods* – E. T. Goodwin.

P. A. Taylor

2437. THEORY OF FUNCTIONS

III – 5 2 – 2 –

Complex numbers, limits and series, analytic functions, Cauchy's theorem, Taylor and Laurent series, singularities and their significance, analytic continuation, contour integration, conformal mapping of one plane region on another. Textbook: *Introduction to Complex Analysis* – Nehari.

F. V. Atkinson

2438. DIFFERENTIAL EQUATIONS

III – 5 2 – 2 –

First order equations solvable by quadratures, the linear equation of general order, operator methods, simultaneous linear equations, Sturm-Liouville systems, numerical methods. Textbook: *Ordinary Differential Equations* – Birkhoff-Rota. References: *Special Functions of Mathematical Physics and Chemistry* – Sneddon; *Differential Equations with Applications* – Ritger and Rose. *P. A. Taylor*

2440. DIFFERENTIAL EQUATIONS AND THEIR NUMERICAL SOLUTION

IV – 5cs 2 – 2 –

Ordinary differential equations, existence and approximation theorems, linear systems, numerical solutions of equations and of eigenvalue problems. Derivation and qualitative properties of second order partial differential equations of elliptic, parabolic, and hyperbolic types, numerical solutions of initial and boundary value problems, stability and convergence.

R. L. Johnston

2443. NUMERICAL ANALYSIS

IV – 3 – – 2 –

Methods of solution of linear systems of equations, round-off errors, roots of equations, quadrature, approximations and rates of conversions, numerical solution of ordinary and partial differential equations. Exercises to be done on the computer will be assigned.

2445. DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS

IV – 5 2 – 2 –

Linear partial differential equations of second order, Green's functions, distributions, eigenvalues and eigenfunctions with applications to wave propagation, heat flow and boundary value problems. Textbook: *Differential Equations of Applied Mathematics* – Duff and Naylor.

R. A. Ross

DEPARTMENT OF PHYSICS

2501. THE STRUCTURE AND PROPERTIES OF MATTER

I – 1, 3, 4, 6, 7, 8, 9 2 1½ 2 1½

An introduction to the mechanical, electrical, magnetic, thermal and optical properties of matter in terms of atoms.

G. D. Scott, E. C. West, T. S. Yoon

2511. PROPERTIES OF MATTER, MECHANICS AND HEAT

I – 5 2 – 2 –

Textbook: *Elementary Classical Physics – Vol. 1* – Weidner and Sells.

K. G. McNeill

2512. PHYSICS LABORATORY

I – 5 – 2½ – 2½

To accompany subject 2511.

K. G. McNeill and the Staff in Physics

2521. PHYSICS

II – 5 3 – 3 –

Fundamental theory of electricity and magnetism. Electromagnetic waves. Interference, diffraction and polarization of light waves. Elementary atomic physics.

J. N. P. Hume

2522. PHYSICS LABORATORY

II – 5 – 3 – 3

To accompany subject 2621.

J. N. P. Hume

2531. STATISTICAL PHYSICS

III – 5a, 5cs, 5e, 5g, 5nt, 5p 2 – – –

The fundamental principles of thermodynamics, kinetic theory and statistical mechanics

J. V. Iribarne

2532. PHYSICS LABORATORY

III – 5a, 5e, 5g, 5nt, 5p – 3 – 3

To accompany subjects 2531, 2533 and 2534.

J. C. Stryland

2533. ATOMIC STRUCTURE AND QUANTUM PHYSICS

III – 5a, 5cs, 5e, 5g, 5nt, 5p – – 4 –

Waves and particles; Schrodinger equation; harmonic oscillator, hydrogen atom, many-electron atoms; nuclear structure; radioactivity; interaction of radiation with matter.

E. J. Allin

2534. PHYSICS OF SOLIDS AND FLUIDS

III – 5e, 5g, 5m, 5p 2 – – –

Elasticity, similarity, equations of fluid motion, wave propagation, potential theory.

R. List

2537. GEOPHYSICS

III – 5g 1 – 1 –

Physics of the earth, its atmosphere, magnetosphere; its evolution and the processes taking place on it.

A. W. Brewer, D. York

2541. ELECTROMAGNETIC RADIATION AND MATTER

IV – 5p 2 – 2 –

Propagation of electromagnetic waves, polarization, diffraction, interference, dispersion, scattering. Absorption, spontaneous and stimulated emission, Einstein coefficients. Coherence, maser and laser action.

H. L. Welsh, A. D. May, R. A. Armstrong

2542. PHYSICS LABORATORY

IV – 5nt – 3 – 3
IV – 5p – 6 – 6

To accompany the lecture subjects 2541, 2544 and 2545.

The Staff in Physics

2543. MOLECULAR PHYSICS AND STATISTICAL MECHANICS

IV – 5p 4 – – –

Quantum theory of rotation and vibration of molecules. Nuclear spins, symmetry, intensity rules, intermolecular forces. Boltzmann theory, transport equations, the Gibbs method, partition functions.

J. D. Poll

2544. NUCLEAR AND HIGH ENERGY PHYSICS

IV – 5nt, 5p – – 4 –

Nuclear phenomena. Properties of elementary particles. Nuclear spectra and structure. Electromagnetic interactions of nuclei. Weak interactions

D. A. L. Paul, R. K. Logan

2545. QUANTUM MECHANICS

IV – 5nt, 5p 2 – 2 –

Schrodinger equation, eigenvalues and eigenfunctions. Angular momentum, Pauli spin theory, identical particles. Perturbation theory, transition probabilities. Scattering theory.

J. W. Moffat

2546. SOLID STATE PHYSICS

IV – 5p – – 4 –

Crystal structure and lattice vectors. Heat capacities. Order-disorder transitions. Electron theory of metals, energy bands. Brillouin zones, electrical and thermal conductivity. Magnetism. Molecular crystals. Rotational and vibrational excitons. Optical properties.

P. A. Griffin, J. M. Daniels

2547. RELATIVITY THEORY

IV – 5p 4 – – –

Special theory: Lorentz transformations. Kinematics and dynamics. Tensor analysis. The Klein Gordon field. General Theory: General tensor analysis. Einstein equations, Schwarzschild metric.

J. Van Kranendonk

2561. THEORY AND APPLICATION OF GEOPHYSICAL METHODS

IV – 5g 2 – 2 –

A course on the mathematical theory of magnetic, electrical, seismic and gravitational methods in applied geophysics. Reference: Grant and West, *Interpretation Theory in Applied Geophysics.*

D. W. Strangway

2568. EXPLORATION GEOPHYSICS

IV – 9 2 – 2 –

An introduction to the physical principles underlying the important methods of geophysical prospecting. Particular attention is given to the seismic, gravitational, magnetic and electromagnetic methods. References: Dobrin, Introduction to Geophysical Prospecting; Parasnis, Mining Geophysics.

G. F. West

2569. GEOPHYSICS

IV – 9 – 3 – 3

To accompany subject 2568.

G. F. West

2570. PHYSICS OF THE EARTH

IV – 5g 2 – 2 –

Seismology and the internal constitution of the earth; the gravitational field; magnetism and magnetic properties of rocks; radioactivity, geothermal heat and the age of the earth. Reference: Coulomb and Jobert, the Internal Constitution of the Earth.

G. D. Garland

2571. ATMOSPHERIC PHYSICS

IV – 5g 2 – 2 –

Meteorological measurements, statics and conditions for equilibrium, thermodynamics, equations of motion, synoptic charts, the general circulation, condensation physics, electricity. Wind structure near the ground, evaporation, the stratosphere.

A. W. Brewer

2573. GEOPHYSICS LABORATORY

IV 5g – 6 – 9

A laboratory course stressing experimental and mathematical techniques applicable to the geophysical sciences.

G. F. West

2574. TECTONOPHYSICS

IV – 5g 2 – 2 –

An examination of the several physical theories proposed for the behaviour of the earth, in terms of seismic, geothermal isotopic, palaeomagnetic and other geophysical and geological observations made over ocean basins, islands and continents.

J. T. Wilson

DEPARTMENT OF CHEMISTRY

2631. ATOMIC AND MOLECULAR STRUCTURE

III – 5c, 5m 2 – 2 –

The application of wave mechanics to some problems of atomic and molecular structure.

J. P. Valleau

DEPARTMENT OF POLITICAL ECONOMY

2720. ECONOMICS

II – All courses 2 – 2 –

An introduction to the study of Economics with special reference to the problems of

the Canadian economy. Those students who obtain a satisfactory term mark will not be required to write the final examination.

J. P. Warner

2730. POLITICAL SCIENCE

III – All courses (elective) 2 – 2 –

An introduction to political science, with special reference to the government of Canada. Those students who obtain a satisfactory term mark will not be required to write the final examination. Reference books: J. A. Corry and J. E. Hodgetts, *Democratic Government and Politics*; R. M. Dawson, *Government of Canada* (revised by Ward).

F. Peers, S. Taube

2734. ACCOUNTING

III – 4 2 – 2 –

Basic accounting principles and procedures, the preparation and interpretation of financial statements, cost accounting, and the use of accounting as a means of control.

R. Paretz

DEPARTMENT OF GEOLOGY

2900. GEOLOGY FOR ENGINEERS

II – 1 – – 2 2

An introductory course in geology with special reference to engineering problems.

A. R. Berger

2901. X-RAY CRYSTALLOGRAPHY

III – 5m, 8 – 2 – 2

A laboratory course in X-ray diffraction methods for students in Metallurgy and Material Science.

E. W. Nuffield

2903. GEOLOGY

IV – 5g 2 2 2 2

Special topics in geology for students in Engineering Geophysics.

The Staff in Geology

2920. PRINCIPLES OF GEOLOGY

II – 9 2 3 2 3
III – 5g 2 2 2 2

Basic concepts of physical and historical geology.

J. B. Currie, G. Norris

2921. MINERALOGY

II – 9 2 4 2 4

Introductory crystallography; the principle of mineralogy; classification and description

of the common minerals; optical theory; the use of the polarizing microscope in the study of minerals; introduction to the study of rocks.

D. H. Gorman, J. C. Rucklidge

2922. GEOLOGICAL DATA PROCESSING BY COMPUTER

II – 9 1 2 1 2

Applied mathematics, probability, and statistics for processing geological data using computer methods.

F. G. Smith

2930. PETROLOGY

II – 9 2 2 2 2

The principles of petrology; the classification, description and interpretation of the sedimentary, igneous and metamorphic rocks. Miscroscopic petrography. One laboratory report.

J. J. Fawcett

2931. STRATIGRAPHY AND SEDIMENTATION

III – 9 2 2 2 2

Principles of stratigraphy with emphasis on tectonic and environmental interpretation of Precambrian and younger rocks. Problems of applied stratigraphy; petrographic interpretation.

F. W. Beales, A. M. Goodwin

2932. TECTONICS

III – 9 1 3 1 3

Geometry of existing deformational structures in the earth's crust, and reconstruction of their mechanical development.

W. M. Schwerdtner

2934. MINERAL IDENTIFICATION LABORATORY

III – 9 – 2 – 2

A continuation of the laboratory work in mineralogy of course 2921.

D. H. Gorman

2935. PHYSICAL GEOCHEMISTRY

III – 9 3 – 3 –

Chemical thermodynamics, phase diagrams, electrochemistry, states of matter, kinetics with examples from natural and experimental mineral systems at a wide range of temperatures and pressures.

G. M. Anderson, S. D. Scott, F. G. Smith

2937. GEOLOGICAL FIELD TRIPS

III – 9

Field trips to places of geological interest during the fall to complement the subjects studied in the III Year.

The Staff in Geology

2940. MINERAL DEPOSITS

IV – 9 2 3 2 3

Systematic mineralogy and phase equilibria of ore minerals. Identification of ore minerals in polished section. Geochemistry of ore-forming processes. Description of important ore deposits and discussion of their genesis.

A. J. Naldrett

2941s. PETROLEUM AND GROUND WATER GEOLOGY

IV – 9 2 3 2 3

Occurrence of oil and gas in sedimentary basins and the geological conditions that govern their entrapment; ground water and its relation to the geology of drainage basins; fluid flow through porous media.

J. B. Currie, W. D. Baines

2943. EXPLORATION GEOCHEMISTRY

IV – 9 1 3 1 3

Use of trace element analysis techniques as an aid to discovery of ore deposits.

G. M. Anderson

2944. MINERAL ECONOMICS

IV – 9 2 – 1 3

Economic principles pertaining to exploration, development and exploitation of mineral deposits.

Staff in Geology

2946. GEOLOGY FIELD CAMP

IV – 9 14 days

A field course in the Tweed area of Ontario immediately following the Annual Examinations between the Third and Fourth Years.

The Staff in Geology

2947. GEOLOGICAL FIELD TRIPS

IV – 9

Field trips to places of geological interest to complement the subjects studied in the IV Year.

The Staff in Geology

DEPARTMENT OF COMPUTER SCIENCE

3310s. INTRODUCTION TO COMPUTER PROGRAMMING

I – 5 – – 1 1

Introduction to algorithms and stored-programme computers; FORTRAN programming; applications to numerical and non-numerical problems; simulations.

The Staff in Computer Science

3338s. ADVANCED PROGRAMMING I

III – 5cs 3 6 – –

Assembly language programming; data structures; assemblers, macro-assemblers, and compilers; techniques of language processing, translation of arithmetic statements; list and string processing; input-output operations.

3339s. ADVANCED PROGRAMMING II

III – 5cs – – 3 6

Programming in, and structure of, several higher level languages; advanced input/output operations; conditional expressions and general macro capability; non-numeric applications, including sorting and merging; structure of operating systems; batch, multiprogramming, multiprocessing, time sharing, and real time systems.

3340s. AUTOMATA THEORY

IV – 5cs 2 – 2 –

Logic, recursive function theory, Turing machines and computability; theory of automata and formal languages; some aspects of graph theory.

3341s. COMPUTER ORGANIZATION

IV – 5cs – – 2 2

Introduction to memory storage devices, number representations, and arithmetic operations. Registers, information flow and control logic. Memory organization and addressing. Operation codes and microprogramming. Various machine organizations, including case studies of stack, multiprocessor, parallel and serial machines.

SPECIAL LECTURERS

3440. ENGINEERING LAW

IV – 1, 3, 4, 7 1 – – –

A subject designed to co-ordinate the practice of engineering and law. Consideration is given to the characteristics, advantages and disadvantages of companies, partnerships and sole proprietorships, the promotion, organization and financing of companies, the duties of employees to employers, the duties and liabilities of engineers, statutes applicable to engineering works, professional engineering associations, construction contracts, workmen's compensation, trade unions and industrial disputes. Textbook: *Engineering Law* – Laidlaw, Young, and Dick.

W. O. Chris. Miller

SCHOOL OF ARCHITECTURE

3540. TOWN AND REGIONAL PLANNING

IV – 1B 1 3 1 3

Problems of world urbanization; nature of the megalopolis, its guidance and control; urban functions and transportation; market analysis and research techniques; urban renewal. Laboratory work includes exercises in survey research and analysis, subdivision layout, and urban analysis.

D. Pinker, A. Waterhouse

VII General Regulations; Examinations

ATTENDANCE

1. Students proceeding to the degree are required to attend the courses of instruction and the examinations in all subjects prescribed. A student whose attendance at lectures or laboratories, or whose work, is deemed by the Council of the Faculty to be unsatisfactory may have his registration cancelled at any time.

2. Students must conform to all lecture room and laboratory regulations. Reports, briefs, theses and drawings become the property of the Council to dispose of as it may see fit. Drawings, briefs and field notes will not be accepted unless they have been made at the time and place provided in the time table.

PENALTIES FOR UNSATISFACTORY WORK

(*a*) In the case of unsatisfactory work of a very serious nature, the Faculty Council may recommend to the Senate that a student be debarred from the University.

(*b*) A student who on two occasions has failed to obtain promotion to a higher year will be refused further registration in the Faculty. A failure in engineering or in a related course at another institution will be counted in the same way as a failure in this Faculty.

(*c*) A student whose work is unsatisfactory may be suspended from attendance by the Council of the Faculty for a period of time not exceeding two years and/or until the satisfaction of other conditions as it may see fit.

(*d*) A student who withdraws after February 15, or who does not withdraw but does not write the annual examinations, will be regarded for the purposes of these regulalations as having failed his year.

APPEALS

A student wishing to appeal to the Senate against a decision of the Council of the Faculty should consult the Secretary of the Faculty or the office of the University Registrar about the preparation and submission of his petition to the Secretary of the Senate.

ANNUAL EXAMINATIONS

1. Annual examinations will be held in April except as provided in paragraph 2 below.

2. Annual examinations will be held at the beginning of the second term in subjects completed during the first term.

3. Promotion from one year to another is made on the basis of the student's weighted average in the annual examinations and laboratory and other term work. Subjects will be weighted according to the number of hours devoted to them, the hours assigned to laboratory subjects being given one half the weight of those in lecture subjects.

Pass standing and promotion to the next higher year will be granted to students who obtain a weighted average of 60% or greater in the work of the year. (For special requirements in the first year of Engineering Science, see page 36.)

4. The student's work is graded in the following manner:

On Overall Average

Marks	Standing
75 – 100%	I Class (Honours)
66 – 74%	II Class
60 – 65%	III Class
Below 60%	Failure

On Individual Subjects

Marks	Grade
75 – 100%	1
66 – 74%	2
60 – 65%	3
50 – 59%	4
Below 50%	5

5. Honour standing will be granted to students who obtain a weighted average of 75% or greater in the work of the year.

6. Honour graduate standing will be granted to students who obtain honours in the final year and in any one previous year.

7. The following regulations pertain to failure and repetition of a year:

(*a*) A student who fails may be permitted to repeat the work of a year, subject to the conditions set out in the following paragraphs of this section.

(*b*) Only one such repetition will be allowed in the student's entire undergraduate course. For the purpose of this regulation, a failure in engineering or in a related course at any other institution will be counted in the same way as a failure in this Faculty.

(*c*) A student repeating a year must take the full program of instruction.

(*d*) A student who fails in the Second, Third or Fourth Year may repeat the work of the year in the session immediately following, unless he has previously repeated a year or is for other reasons ineligible.

(*e*) A student who has been admitted to advanced standing and who fails in his first year of attendance must file an application for re-admission, following the procedure outlined in Section III, paragraph 6 of this calendar.

(*f*) A student who fails in the work of the First Year may apply for re-admission

to the Faculty, subject to the conditions set out below. *Applications of students for re-admission to the First Year will be considered on their merits, in competition with all other applicants.*

(i) A student who fails in the work of the First Year but who has obtained an average of 50% or over may apply for re-admission in the session immediately following.

(ii) A student who fails in the work of the First Year with an average lower than 50% may not apply for re-admission until one full session has elapsed.

(iii) A student who withdraws on or before February 15 may apply for re-admission in the session immediately following.

(iv) A student who withdraws after February 15, or who does not withdraw but does not write the final examinations is considered to have failed, and may not apply for re-admission until one full session has elapsed.

(v) Application for re-admission is made to the Office of Admissions on the regular admission application form, as outlined in Section III, paragraph 6, of this calendar.

9. A student should submit to Council immediately after its occurrence, evidence of any illness or mishap which occurs during the session; any petition for leniency on account of such incidents may be refused consideration if received after the third day following the last day of examinations.

10. A student will not be allowed to write any examinations if he has not paid all fees and dues for which he is liable at that time.

TERM EXAMINATIONS

Term examinations may be held in any subject and at any time at the discretion of the instructor, or by the order of the Council, and the results of such examination may be incorporated with those of the annual examinations in the same subjects.

EXTRA-CURRICULAR ACTIVITIES AND ACADEMIC CREDIT

It is in general desirable for students to engage to a reasonable extent in extra-curricular activities in order that they may not become too narrowly professional in interests and outlook, but it will be obvious that no academic credit or consideration can be given for such activities. Some offices in student organizations require quite large amounts of time for the proper performance of the duties connected with them, and it is therefore strongly recommended that students, particularly those whose academic records are not high, consult a senior member of staff before allowing themselves to be nominated for such offices.

TRANSFER OF COURSE

An undergraduate student who wishes to transfer from one course to another within the Faculty must petition to the Faculty Council and obtain its approval. Petitions for transfer of course must be submitted not later than July 15.

VIII Medals, Prizes, Scholarships and Bursaries

Through the generosity of friends of the University, governments and commercial organizations, encouragement has been given to undergraduate work in the various branches of engineering study by the establishment of the scholarships, prizes, bursaries and medals listed in the following pages.

ADMISSION SCHOLARSHIPS AND BURSARIES

Ontario Students:

Scholarships and bursaries available to students entering the First Year are listed on pages 124 and 125. For full details concerning these awards, applicants should consult the Calendar of Admission Awards, which is available at Secondary Schools or from the Office of Student Awards, Simcoe Hall, University of Toronto. Applications, which must be made through the Principal of the Secondary School, close on May 1 annually.

Non-Ontario Students:

All non-Ontario students should apply to the Office of Student Awards, Simcoe Hall, University of Toronto. A limited number of scholarships is reserved for students living outside the Province of Ontario, but as competition is keen such students must not count on receiving assistance but are advised rather to ensure that they have sufficient funds from their own government or from private sources to cover all probable expenses.

IN-COURSE SCHOLARSHIPS AND BURSARIES

Scholarships, prizes, bursaries and loans available to students in attendance in the Faculty are listed on pages 125 to 128. Where it is necessary to make application for an award it is so stated in the description and particulars are given as to how the application should be made. In all other cases the award is made on the recommendation of the Faculty Council and no application is necessary.

GENERAL TERMS AND CONDITIONS

In order to be eligible for a medal, prize, scholarship, bursary, fellowship or other award granted solely upon standing obtained at an annual or special examination or upon an essay, or term work, or other academic rating, a candidate must obtain

honours at such annual or special examination or upon such essay, term work, or other academic rating unless the terms of the award specify that standing lower than honours may be accepted.

When an award or medal is granted upon standing obtained on part of the work of any academic year the candidate must obtain standing but need not obtain honours in the work of the academic year as a whole, provided he obtains honours in the part concerned, unless the terms of the award or medal specify otherwise.

No medal, prize, scholarship, bursary, fellowship or other award will be granted to a candidate who is conditioned in any subject at an annual examination unless the terms of the award or medal specify otherwise.

A candidate will not be permitted to receive more than one award in a session unless the statute establishing each of the awards concerned or the Calendar specifies otherwise. Only one of those marked by an asterisk may be held in any one year. A candidate who would, but for this provision, have received more than one award may have his name so published in the class lists.

A candidate who has spent two sessions in any year of an undergraduate course is not eligible to compete for any award at the annual examinations of that year.

Medals, after they have been suitably engraved, will be given without delay to the winners or forwarded to them by registered mail.

Awards granted to members of graduating classes other than awards for graduate study and research, will be paid in one instalment as soon as possible after the granting of the awards.

All other awards will be paid (i) if of the value of $100 or less, in one instalment on November 20 and (ii) if of the value of more than $100 in two equal instalments, the first on November 20 and the second on January 20, in the session following the granting of the awards. Payment will be made only if the candidate is in regular attendance in the Faculty and, if the Calendar so specifies, in the course in which the award is established or granted.

The Senate may, on the recommendation of the Faculty, permit a candidate to whom an award has been granted to postpone attendance upon lectures and laboratory classes for one year. Further postponement may be permitted on application.

NOTE – As the value of an endowed scholarship or prize is dependent on the actual income of the fund, it is possible that the value of certain scholarships and prizes at the time of payment may be greater or less than the amount stated in the calendar.

In those cases where the amount of the award is not payable from income earned on an endowed fund, payment will be dependent on the receipt of the amount of the annual award from the donor.

AVAILABLE TO STUDENTS ENTERING THE FIRST YEAR

(† *indicates that application is required*)

Alumni Association War Memorial Scholarships	†	$ 500	page 153
Alcan Scholarship	†	$ 500	129

J. P. Bickell Foundation Scholarships	†	$ 500	page 132
J. W. Billes Admission Scholarships	†		133
Children of War Dead Education Assistance	†		134
Dominion Magnesium Limited Bursary	†	$ 400	135
Engineering Alumni Admission Scholarships (7)	†	$1000	136
Grabill Admission Scholarship	†	$ 500	138
General Foods Scholarships	†	$ 500	138
Hagarty Memorial Scholarship	†	$ 60	138
The Murray Calder Hendry Scholarship	†	$ 500	139
Roy Jarvis Henry Admission Scholarships (3)	†	$ 500	140
International Nickel Scholarship	†	$ 300 + Fees	140
The Leonard Foundation Scholarships	†		141
J. Edgar McAllister Foundation	†		142
Lachlan Dales McKellar Admission Scholarships (2)	†	$ 500	144
O.H.A. War Memorial Scholarship	†	$ 200	146
Ontario Chapter American Society for Metals Bursaries (2)	†	$ 400	130
Ontario Student Awards Programme	†		135
A.P.E.O. Admission Scholarship	†	$ 500	147
Regular Officer Training Plan	†		149
Helen E. Rogers Admission Scholarships	†		149
Simpson-Sears Limited (Northern Ontario) Scholarship	†	$ 100	151
Walter Sterling Admission Scholarships	†		152
U.T.S. Engineering Scholarship	†	$ 250	154
Wallberg Admission Scholarships (2)	†	$ 500	154

AVAILABLE TO STUDENTS COMPLETING THE FIRST YEAR

(† *indicates that application is required*)

Atkinson Incourse Bursaries	†		130
Baptie Scholarship		$ 175	131
Canadian Bechtel Limited Bursaries	†		131
J. P. Bickell Foundation Scholarships			132
T. H. Bickle Prize		$ 30	133
Crocker Foundation Bursaries	†		135
John M. Empey Scholarship		$ 170	136
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		140
Inco Scholarship	†		140
Johnson's Wax Scholarship		$ 800	141
Kimberly-Clark Scholarship		$ 500	141
John Wolfe McColl Awards	†		142
Garnet W. McKee-Lachlan Gilchrist Scholarship in Engineering Science		$ 110	143

MacLennan – MacLeod Memorial Prize		$ 25	page 144
*Marsland Engineering Ltd. Scholarship		$ 250	145
Ontario Student Awards Programme	†		135
Orenda Limited Scholarship		$ 500	146
Paulin Memorial Scholarship		$ 475	147
Procter and Gamble Bursary	†		147
*Professional Engineers Scholarship		$ 250	147
Ransom Scholarship in Chemical Engineering		$ 250	148
Frederick W. Schumacher Scholarship	†		150
S. Ubukata Fund	†		153
*Wallberg Undergraduate Scholarships (2)		$ 500	154

AVAILABLE TO STUDENTS COMPLETING THE SECOND YEAR

(† *indicates that application is required*)

Harvey Aggett Memorial Scholarship		$ 75	129
Ardagh Scholarship		$ 350	130
Association of Ontario Land Surveyors Scholarship	†	$ 500	130
Automotive Transport Association Bursary	†		131
Babb Bursary Fund	†		131
Canadian Bechtel Limited Bursaries	†	$1200	131
J. P. Bickell Foundation Bursaries	†		132
J. P. Bickell Foundation Scholarships			132
T. H. Bickle Prize		$ 30	133
Carveth Metallurgical Ltd. Bursary	†	$ 500	134
5T6 Civils Scholarship	†	$ 200	134
Crocker Foundation Bursaries	†		135
Cyanamid of Canada Scholarship		$ 900	135
John M. Empey Scholarship		$ 170	136
J. A. Findlay Scholarship		$ 80	137
Hugh Gall Award	†	$ 140	138
Hydro-Electric Power Commission of Ontario Bursary	†	$ 500	140
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		140
Kimberly-Clark Scholarship		$ 500	141
Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarships			143
Charles Gordon Manning Prize			144
*Marsland Engineering Ltd. Scholarship		$ 250	145
James L. Morris Memorial Prize		$ 125	145
Ontario Student Awards Programme	†		135
Orenda Limited Scholarship		$ 500	146
*Spruce Falls Power and Paper Company Scholarships		$ 400	page 152

William Storrie Memorial Scholarship		$ 100	152
*Professional Engineers Scholarship		$ 250	147
*Rhodes Scholarship	†	£1000	148
Frederick W. Schumacher Scholarship	†		150
Edith Tyrrell Memorial Bursary	†	$ 600	153
*Wallberg Undergraduate Scholarships		$ 500	154
William R. Worthington Memorial Scholarship		$ 400	155

AVAILABLE TO STUDENTS COMPLETING THE THIRD YEAR

(† *indicates that application is required*)

American Institute of Industrial Engineers Scholarship		$ 150	129
Babb Bursary Fund	†		131
F. W. Baldwin Prize		$ 75	131
Canadian Bechtel Limited Bursaries	†		131
J. P. Bickell Foundation Bursaries	†		132
T. H. Bickle Prize		$ 30	133
*Boiler Inspection and Insurance Company Scholarship		$ 300	133
*Chevron Standard Limited Scholarship		$ 500	133
Chemical Institute of Canada Prize		$ 25	134
Crocker Foundation Bursaries	†		135
Dow Chemical of Canada Limited Award		$ 500	136
John M. Empey Scholarship		$ 170	136
E.I.C. Prize		$ 50	137
Engineering Society Semi-Centennial Award		$ 75	137
J. A. Findlay Scholarship		$ 80	137
James Franceschini Foundation Scholarship		$ 250	137
Chester B. Hamilton Scholarship		$ 500	139
I.B.M. – Thomas J. Watson Memorial Bursary Fund	†		140
Cominco Scholarships	†	$ 800	134
*Jenkins Scholarship in Engineering		$ 200	141
Loan Funds	†		155
J. A. D. McCurdy Prize		$ 75	142
Alexander MacLean Scholarship		$ 250	144
*Marsland Engineering Ltd. Scholarship		$ 250	145
Ontario Student Awards Programme	†		135
Orenda Limited Scholarship		$ 500	146
*Professional Engineers Scholarship		$ 250	147
RCE Memorial Scholarship	†	$ 125	149
Don Salt Memorial Scholarships	†	$ 500	150
Murray F, Southcote Scholarship		$ 100	152
Frederick W. Schumacher Scholarship	†		page 150

William Storrie Memorial Scholarship		$ 100	152
*Spruce Falls Power and Paper Company Scholarships		$ 400	152
Edith Tyrrell Memorial Bursary	†	$ 600	153
*Wallberg Undergraduate Scholarships		$ 500	154

AVAILABLE TO STUDENTS COMPLETING THE FOURTH YEAR

(† *indicates that application is required*)

Henry G. Acres Medal			128
American Society of Lubrication Engineers Prize		$ 75	129
J. P. Bickell Foundation Bursaries	†		132
Babb Bursary Fund			131
Crocker Foundation Bursaries	†		135
Electrical Manufacturing Co. Limited Prize		$ 25	136
Hamilton Watch Award			139
Loan Funds	†		155
Massey-Ferguson Ltd. Scholarships (2)	†	$ 500	145
Ontario Student Awards Programme	†		135
Otto Holden Scholarship		$750	146
Professional Engineers Gold Medal			147
J. E. Reid Memorial Prize		$ 50	148
William Storrie Memorial Scholarship		$ 200	152
Wallace Award, Society of Automotive Engineers Prize		$ 100	151
Society of Chemical Industry Merit Award			151
"Second Mile Engineer" Award		$ 200	150
W. S. Wilson Medals			155

HENRY G. ACRES MEDAL

The Henry G. Acres Medal is the gift of Mrs. Henry G. Acres in memory of her late husband, Henry G. Acres, M.E., D.Sc., a graduate of the School of Practical Science in the class of 1903. Throughout his professional life Dr. Acres was associated with major power developments in Canada and abroad. As chief hydraulic engineer for the Hydro-Electric Power Commission of Ontario in the period 1911 to 1923, he was responsible for the design and construction of nearly twenty power plants, including the Queenston-Chippewa development. Entering private practice in 1924, and until his death in 1945, he continued to widen and extend his interests. He became chief engineer of the Grand River Conservation Commission and responsible for the design and construction of the Shand dam and related work. Later, he was consulting engineer for the extensive power developments at Shipshaw on the Saguenay River, which was vital to the production of aluminum for war purposes. Many of the provinces of Canada sought his services and he advised with respect to work in Newfoundland, South America and India.

This medal is awarded annually to the student in the Fourth Year who is registered in the course in Civil, Mechanical, or Electrical Engineering, and who obtains the highest aggregate percentage at the annual examinations of the Third and Fourth Years, provided always that the student obtains honour standing in the examinations of the Fourth Year. Receipt of the medal does not preclude a student from being granted such other award as may in the opinion of the Council be appropriate.

HARVEY AGGETT MEMORIAL SCHOLARSHIP

This scholarship was donated by the late Mr. J. T. Aggett, of Toronto, as a perpetual memorial to his son, the late Lieutenant Harvey Aggett, who enlisted in March, 1915, during his second year in this Faculty, and was killed in action at Passchendaele on November 6, 1917.

This annual scholarship of the value of the annual income from the fund is to be awarded to a student of the Second Year in this Faculty who, obtaining honours and being one of the first three in his year by his standing at the annual examinations, has been adjudged highest of the three in general student activities and service in the University during his period of attendance. When regulations do not permit the winner to hold this scholarship the students to be considered for the award shall be the first three in the year exclusive of any student who holds a scholarship of higher value.

ALCAN SCHOLARSHIP

The Aluminum Company of Canada, Limited, has made available an admission scholarship of a value of $500 to a student entering the First Year of an Honours Course in the Faculty of Arts and Science, the Faculty of Applied Science and Engineering or in the Faculty of Law. The recipient must attain an academic standing satisfactory to the Committee of Award and demonstrate financial need. It is tenable in the later years provided First Class standing is maintained.

Application should be made to the Registrar of the University by May 1 on the regular Admission Scholarship Application form.

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS SCHOLARSHIP

The Southern Ontario Chapter, American Institute of Industrial Engineers offers a scholarship of $150 to a student entering the Fourth Year of the Industrial Engineering course who has consistently maintained a high academic standing, but not necessarily honour standing, during the previous three years.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS PRIZE

The Toronto section of the American Society of Lubrication Engineers offers an annual prize of $75 to a student in the Fourth Year in Mechanical Engineering whose Thesis dealing with Lubrication is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory. The Prize

is accompanied by a donation of $25 to the Department to purchase books on Lubrication.

ONTARIO CHAPTER, AMERICAN SOCIETY FOR METALS BURSARY

The Ontario Chapter, American Society for Metals provides two bursaries of a value of $400 each for students entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made for the Session 1958–59.

ARDAGH SCHOLARSHIP

The Ardagh Scholarship, of the annual value of the income from $7,500, has been provided in memory of his parents by Professor E. G. R. Ardagh, B.A.Sc., F.R.S.C., formerly professor of Applied Chemistry in the Faculty. It is awarded to the student who attains the highest standing in all Honours at the annual examination of the Second Year in the Course in Chemical Engineering. The first award was made on the results of the annual examination of 1946.

ASSOCIATION OF ONTARIO LAND SURVEYORS SCHOLARSHIP

The Association has established a scholarship of $500 to be awarded to a student registered in the Surveying Option in the Third Year of the course in Civil Engineering at the University of Toronto or an equivalent course at any other University. This award will be granted by the Association at its annual meeting in February with due consideration being given to the following points:

(a) Through his activities, the student must show leadership ability and give promise of becoming a worthwhile influence in the affairs of the profession.

(b) While attention is given to scholastic ability, as evidenced by his academic standing, other factors also will be considered.

(c) Special consideration is to be given to financial need.

Students must apply to the Secretary of the Association of Ontario Land Surveyors, 8 King Street East, Toronto 1, Ontario, by letter prior to December 31 of the calendar year preceding that in which the award is to be granted.

ATKINSON IN-COURSE BURSARIES

Atkinson In-Course Bursaries, gift of the Atkinson Charitable Foundation, are awarded annually to students in the second or higher years of their courses. Applicants must have at least Second Class honours in the final examinations of the preceding year, demonstrate financial need and be a resident of the Province of Ontario.

Applications must be submitted to the Registrar of the University on or before December 1.

ATA TRUCKING INDUSTRY EDUCATIONAL FOUNDATION BURSARIES

The Automotive Transport Association of Ontario has established a bursary fund for students in the second or higher years of any undergraduate degree course who find themselves in serious financial need due to sudden, unexpected personal or family difficulties. Applications may be submitted to the University Registrar at any time during the session and the number and value of the bursaries will vary at the discretion of the Committee of Award.

THE BABB BURSARY FUND

Bursaries from this fund are available to students in any year of the Aeronautics Option in Engineering Science. Application is made through the Secretary of the Faculty.

THE F. W. BALDWIN PRIZE

The F. W. Baldwin Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44), in memory of Frederick Walker "Casey" Baldwin, a graduate of the School of Practical Science, who made a significant contribution in the field of Aeronautics in Canada; and who flew, on March 12, 1908, near Hammondsport, N.Y., the "Redwing," the first biplane built by the Aerial Experiment Association.

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in the annual examinations of Third Year in "structural subjects."

The first award was made on the results of the examinations of the Session 1953–54.

BAPTIE SCHOLARSHIP

The Baptie Scholarship is derived from a bequest under the will of the late Mrs. Margaret W. Baptie, of Ottawa, and the Board of Governors has directed that a scholarship of one half the annual income shall be awarded annually to an engineering student on the record of the first Year. The Board of Governors also authorizes a remission of fees in the case of the holder of the scholarship, up to $75.

The conditions of the award are as follows: That the scholarship be awarded to the student who, in the annual examinations of the First Year, enrolled in any one of the courses of Civil Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, or Metallurgy and Materials Science, obtains the highest aggregate percentage of marks in those subjects which are common to the First Year curricula of those courses. The first award was made on the results of the annual examinations of the Session 1925–26.

CANADIAN BECHTEL LIMITED BURSARIES

Canadian Bechtel Limited has established Bursaries in the Faculty of Applied Science and Engineering of an annual value of $1,200 to provide not more than four awards,

each of a minimum value of $200 and a maximum value of $600. Two awards will be made to First Year students and one or two awards to students registered in any year of the Faculty. Applicants must demonstrate financial need and have academic standing satisfactory to the Faculty Council.

Application must be made to the Secretary of the Faculty on or before October 1.

J. P. BICKELL FOUNDATION SCHOLARSHIPS

The Trustees of the J. P. Bickell Foundation have established scholarships, the number to be determined annually, in the Faculty of Applied Science and Engineering of a possible value of $1,500 payable $500 in the First Year and provided honours are obtained at the Annual Examinations, $500 in the Second and Third Years.

An applicant must obtain an average of at least 75% at the Ontario Grade XIII examinations immediately preceding his admission to the university and must undertake to enrol in Chemical Engineering, Metallurgy and Materials Science or Geological Engineering. Failing suitable candidates in the courses mentioned students registered in the Second Year Honour course in Geological Sciences, or Physics and Geology in the Faculty of Arts and Science who are academically qualified are eligible. These awards are of the same value and are tenable in the Second, Third and Fourth Years of the course, subject to maintenance of the required academic standing. If any scholarships are not awarded to those mentioned above, students registered in the Third Year of the Engineering Science course in the Faculty of Applied Science and Engineering and taking the Physical Metallurgy or the Geophysics option who are academically qualified are eligible. In this case the scholarship will have a value of $1,000, payable $500 in each of the Third and Fourth years, provided the required academic standing is maintained.

Applications from those entering First Year must be submitted to the Registrar of the University not later than May 1 on the regular admission scholarship application form. In other cases, applications are not required.

J. P. BICKELL FOUNDATION BURSARIES

The Trustees of the J. P. Bickell Foundation have established the J. P. Bickell Foundation Bursaries in the Faculty of Arts and the Faculty of Applied Science and Engineering. An applicant must be enrolled in Honour Science or in Mathematics, Physics and Chemistry in the Faculty of Arts, in which case he must undertake to study mining or geology in his higher years; or be enrolled in a higher year of an honour course in the geological or geophysical field in the Faculty of Arts; or be enrolled in Chemical Engineering, Mining Engineering, Metallurgy and Materials Science, or Geological Engineering in any year of the Faculty of Applied Science and Engineering. He must demonstrate financial need and have satisfactory academic standing.

Application must be made to the Registrar of the University on or before December 1.

THE T. H. BICKLE PRIZE

The T. H. Bickle Prize is the gift of Mr. and Mrs. E. W. Bickle in memory of their son, T. H. Bickle, an undergraduate of Trinity College and a member of the Senior Intercollegiate Swimming Team at the time of his death in 1937. The income from the endowment fund will be used to purchase a suitable prize to be awarded annually to a member of the Senior Intercollegiate Swimming Team of this University in any year, faculty or school. The Committee of Award shall consist of the Dean of the Faculty of Arts, the University Registrar, the Director of Athletics, and the Honorary Coach of Swimming. In awarding the Prize the Committee shall consider the character, scholarship, and general interests of the members of the team.

J. W. BILLES ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of J. W. Billes, open to students entering any degree course in the University. The value in each year is a minimum of $200 and a maximum of $1,500 dependent upon the financial need of the recipient. Applicants must satisfy the normal admission scholarship standards in their Grade XIII examinations to be eligible for an award and maintain first class honour standing to enjoy the scholarship in higher years. The number of scholarships awarded in any one year may be varied dependent upon the available funds.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

BOILER INSPECTION AND INSURANCE COMPANY SCHOLARSHIP

The Boiler Inspection and Insurance Company of Canada offers a scholarship in the Course in Mechanical Engineering of the value of $300 to the student who obtains highest honour standing in the regular examinations of the Third Year.

The successful candidate will be expected to proceed to his Fourth Year during the session next following the date of the award.

The amount of the award will be credited by the Chief Accountant to the fees of the Fourth Year of the successful candidate.

CHEVRON STANDARD LIMITED SCHOLARSHIP

Chevron Standard Limited has presented a scholarship of $500 to a student who achieves outstanding results in the annual examinations of the Third Year in the Geophysics Option in Engineering Science or in Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and Science.

The awards alternate annually between the Faculties of Applied Science and Engineering and Arts and Science and the First Award was made in the session 1960–61 in the Faculty of Applied Science and Engineering.

CARVETH METALLURGICAL LTD. BURSARY

Carveth Metallurgical Ltd. provides one or more bursaries to a total value of $500 for students entering the Third Year of Metallurgy and Materials Science. The award is made primarily on the basis of Second Year standing, but the need for financial assistance will also be taken into consideration.

The Bursary is available every third year, beginning in the Session 1961–62, and is to be awarded on the recommendation of the Department of Metallurgy and Materials Science. Applications should be made by letter to the Secretary of the Faculty of Applied Science not later than September 1 of the year in which the award is tenable.

CHEMICAL INSTITUTE OF CANADA PRIZE

The Chemical Institute of Canada offers a prize of the annual value of $25 in books to the student registered in the course in Chemical Engineering who, having obtained honours, receives the highest standing in the written and laboratory work of the Third Year.

The first award was made on the results of the final examinations of 1947.

CHILDREN OF WAR DEAD (EDUCATION ASSISTANCE) ACT

Children of War Dead (Education Assistance) Act provides fees and monthly allowances for children of veterans whose death was attributable to military service. Enquiries should be directed to the nearest District Office of the Department of Veterans Affairs.

5T6 CIVILS SCHOLARSHIPS

The 5T6 Civils, consisting of the graduating members of the 1956 Civil Engineering Class of the University of Toronto, have established an annual scholarship of the value of $200.00 open to students in the Second Year of the course in Civil Engineering. The selection of the recipient is based on evidence of the qualities of scholarship, leadership and character. The award is not tenable with any other scholarship of greater value.

The award is presented at the annual reunion of the Class of 5T6 Civils. The first award was made in 1964.

Students who wish to be considered for this scholarship should write to the Class of 5T6 Civil Engineering, c/o Alumni House, University of Toronto, not later than December 31, giving full particulars of their academic record, and their extra-curricular activities both within and outside the University.

COMINCO SCHOLARSHIPS

Two scholarships, of an annual value of $800 each, are provided by Cominco Limited and are offered to students in the Third Year of the courses in Chemical Engineering, Geological Engineering, Mechanical Engineering and Metallurgy and Materials Science in the Faculty of Applied Science and Engineering and to students in the Third Year of the courses in Chemistry and Geology in the Faculty of Arts and Science, the

awards being made on the basis of the examination results of the Seecond Year. The scholarships may be renewed in the Fourth Year if satisfactory standing is maintained.

Application must be made to the Secretary of the Faculty on the regular in-course awards form not later than October 15.

CROCKER FOUNDATION BURSARIES

The income from a capital fund established from the estate of the late Beatrice Crocker Glazier in memory of her brother, James William Crocker, provides bursaries for students in the Faculty of Medicine and the Faculty of Applied Science and Engineering who are in need and are worthy of financial assistance.

Application should be made to the Secretary of the Faculty not later than October 15.

CYANAMID OF CANADA SCHOLARSHIP

As a part of their programme to encourage technical development in Canada, Cyanamid of Canada Limited offers a scholarship of the value of $900 to a student entering the Third Year in Chemical Engineering or Industrial Engineering. The award is made to a student who has demonstrated high academic ability and outstanding scholarship in the work of the Second Year.

The first award at the University of Toronto was made in 1964.

DOMINION MAGNESIUM LIMITED BURSARY

Dominion Magnesium Limited provides a bursary of $400 for a student entering the First Year in Metallurgy and Materials Science. The award is made primarily on Grade XIII standing but the need for financial assistance is also taken into consideration.

Application should be made by letter to the Secretary not later than September 1. The first award was made in the Session 1958–59.

PROVINCE OF ONTARIO STUDENT AWARDS PROGRAMME

Awards under this programme will be made available to all Ontario students provided:
(i) they are in full-time attendance at a Canadian University (or other eligible institution).
(ii) they can demonstrate need for financial assistance.
(iii) they are either Canadian citizens or landed immigrants, have resided in Canada for at least twelve months and intend to reside permanently in Canada.

Each applicant's need will be assessed by the Department of University Affairs and the first $150 of the total established need will be paid in loan form. Of the balance 60% will be made available as a loan and 40% will be in the form of a bursary.

Application forms and further information are available at high schools for students entering the first year; students in attendance in the Faculty may obtain application forms from the Secretary.

DOW CHEMICAL OF CANADA LIMITED AWARD

Dow Chemical of Canada Limited have provided funds for an annual award of $500 to a student in Chemical Engineering in the Faculty of Applied Science and Engineering, and grant-in-aid of $250 to be used in the winner's department to help defray the cost of equipment, supplies and administration.

The winner must:

(*a*) be registered in the Third Year in Chemical Engineering (the award will be made in the second term of the Third Year and will be paid to the winner during his Fourth Year);

(*b*) be in the upper half of the class;

(*c*) have demonstrated leadership in extra-curricular activities.

The award is not tenable with other awards in the gift of the Senate. Application is not required.

THE ELECTRICAL MANUFACTURING COMPANY LIMITED PRIZE

The Electrical Manufacturing Company Limited has established an annual Prize of $25 in the Faculty of Applied Science and Engineering.

The winner must:

(*a*) be registered in the Fourth Year in Electrical Engineering;

(*b*) obtain the highest aggregate percentage of marks at the final examinations in the subjects of the Fourth Year related to electrical distribution equipment, the subject to be determined by the Head of the Department of Electrical Engineering.

This Prize is tenable with other awards in the gift of the Senate.

THE JOHN M. EMPEY SCHOLARSHIPS

The John M. Empey Scholarship Fund was established under a bequest of $10,000 in the Will of the late John Morgan Empey, B.A.SC., 1903. Three scholarships of equal value are provided from the income from the Fund. One of these scholarships is awarded in each of the First, Second, and Third Years on the results of the annual examinations, to a student who, taking honours, obtains the highest average percentage of marks in the written and laboratory subjects of his Year. The scholarships are open to any students registered in the Faculty. In case the winner of any one of these scholarships does not attend this Faculty during the session next following the award, the right to the scholarship shall be forfeited and the award shall be made to another eligible student. The scholarships were awarded for the first time in 1944.

ENGINEERING ALUMNI ADMISSION SCHOLARSHIP

Seven scholarships, each of the value of $1000, are provided annually by the University of Toronto Engineering Alumni Association for students entering the first year of any course in the Faculty of Applied Science and Engineering. The awards are made on the basis of standing in the Ontario Grade XIII examinations.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

ENGINEERING INSTITUTE OF CANADA PRIZE

The Engineering Institute of Canada, having in view that one of its objects is to facilitate the acquirement and interchange of professional knowledge among its members, offers an annual prize of Fifty Dollars in this University, commencing 1931, to the student who, in his Third Year in any one of the six courses of Engineering, has proved himself most deserving as disclosed by the examination results of the year, in combination with his activities in the Engineering Society or with a local branch of another recognized engineering organization.

ENGINEERING SOCIETY SEMI-CENTENNIAL AWARD

The Engineering Society Semi-Centennial Award, to the value of $75 was established in 1931 to commemorate the semi-centennial of the founding of the "School." The award is made to a student entering the final year.

The selection is based upon the following qualifications, which bear equal weight in the selection of the winner: (*a*) General "School" activities. (*b*) Contributions to the Engineering Society Executive Committee. (*c*) Personality, and social and athletic activities. (*d*) Academic standing.

J. A. FINDLAY SCHOLARSHIPS

These scholarships were established through a legacy bequeathed by the late Miss Janet Findlay to the Department of Mechanical Engineering. Two scholarships are available, each of a value of one half of the income of the fund, to students in this Course, one for a student in the Third Year, the other for a student in the Fourth Year, but only if the student continues his course in Mechanical Engineering. The selection will be made, on recommendation of the Head of the Department of Mechanical Engineering, from amongst the four students having the highest average percentage of marks at the annual examinations in the Second and Third Years respectively, but in making the award the student's general character, fitness for his profession, and financial circumstances will be given consideration. In case a student who has been awarded one of the scholarships changes his course or does not attend this University during the next following session, he shall forfeit his right to the scholarship and the award shall be made to another eligible student.

THE JAMES FRANCESCHINI FOUNDATION SCHOLARSHIP

This scholarship, of a value of $250, is awarded to the student in Civil Engineering who achieves the highest standing, with honours, at the annual examinations of the Third Year among those who do not hold an award of a value of $100 or more based on the results of these examinations.

HUGH GALL AWARD

The Hugh Gall Award, of the annual value of One Hundred and Forty Dollars, the gift of the Graduate Class of 1910, "to commemorate a deceased classmate who was a splendid type of student, a loyal friend, and nationally outstanding in athletic achievement during his undergraduate career," was established in 1946 for a five year period and, through the generosity of Mrs. Hugh Gall extended for a further period. It is awarded to a student, who, having completed his First Year with a general average of at least 66% without conditions, has entered the Second Year, and is in special need of financial assistance in order to enable him to continue his course. It is desirable, but not necessary, that the recipient shall not already have been given any other scholastic award or scholarship applicable to the second year and he shall have shown indications of his firm intention and ability to follow successfully the profession of engineering.

Any second year student in the Faculty of Applied Science and Engineering is eligible to apply for this Bursary. Applications should be made to the Secretary of the Faculty not later than one month after the opening of the session.

GENERAL FOODS SCHOLARSHIP

This scholarship is awarded for general proficiency in the final secondary school year to a student entering the Faculty of Arts and Science, Applied Science and Engineering or Food Science, and is open for competition by any student resident in Canada. The value is $500 for each of four years, providing first class standing is maintained.

Ontario residents apply on the regular admission scholarship application form.

Students resident outside Ontario may obtain application forms from the Awards Department, Office of the Registrar, University of Toronto.

THE GRABILL ADMISSION SCHOLARSHIP

The Grabill Admission Scholarship is the gift of Mr. Dayton L. Grabill, a graduate of this Faculty in 1924. The Scholarship has a value of approximately $500. It is awarded to the candidate who has standing amongst those with the highest average percentages in the subjects of Ontario Grade XIII required for admission to the Faculty of Applied Science and Engineering. The candidate must write the Grade XIII examinations at one sitting in the June preceding entry to the University after not more than one year's instruction in Grade XIII and must register in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University on the regular Admission Scholarship form by May 1.

THE REGINALD AND GALER HAGARTY SCHOLARSHIP

The Reginald and Galer Hagarty Scholarship, in memory of the dearly beloved sons of Lieutenant-Colonel E. W. Hagarty, B.A. 1883, M.A. 1908, and Charlotte Ellen Hagarty, his wife. Reginald Edward Walter Hagarty, B.A.SC. (Honours) 1908, a

graduate of the University in the Faculty of Applied Science and Engineering and at the time of his death on April 29, 1925, a Consulting Structural Engineer. Lieutenant Daniel Galer Hagarty, Princess Patricia's Canadian Light Infantry, a member of the class of 1916 in Applied Science, enlisted for the Great War at the end of his third year in June, 1915, killed in action in Sanctuary Wood, June 2, 1916. The scholarship is given in recognition of the fact that their father was an honour graduate in Classics of the University of Toronto. It is of the value of the annual interest on the capital sum of $2,000 and is to be awarded to a student who has been enrolled for his Grade XIII Year at Harbord Collegiate Institute and having obtained at least the required standing in each of the Grade XIII subjects necessary for admission to the Faculty, obtains the highest standing in English, a language other than English, and Mathematics, among the students who apply for the award from the Collegiate. He will be required to: (*a*) register in the Faculty of Applied Science and Engineering, (*b*) sign a declaration to the effect that he is willing to take up arms in the defence of Canada and the British Commonwealth should necessity arise as declared by the Parliament of Canada. The Scholarship was offered for award for the first time in 1945. Application should be made to the Registrar of the University on the regular admission scholarship application form not later than May 1.

CHESTER B. HAMILTON SCHOLARSHIP

Members of the family of the late Chester B. Hamilton, a graduate of the Faculty in 1906, have presented a Scholarship in his memory of the annual value of $500. It is held by a Fourth Year student in Mechanical Engineering who has achieved outstanding academic standing at the Annual Examinations of the Third Year.

The first award was made on the results of the examinations for the Session 1958–59.

HAMILTON WATCH AWARD

Hamilton Watch Company, Lancaster, Pa., presents a wrist watch, suitably engraved, to the Fourth Year student in the Faculty of Applied Science and Engineering who at the annual examinations attains Honour standing and who has achieved high aggregate marks during his four years in the social-humanistic subjects common to all courses.

THE MURRAY CALDER HENRY SCHOLARSHIP

This award was established by the estate of Mrs. Grace Appel Hendry as a memorial to her husband, a graduate of this Faculty in 1905. It has a value of the income from a capital sum of $10,000 and the recipient must:

(*a*) have attained an average of at least 75% on the grade XIII examination papers, written at one sitting, required for admission to the Faculty.

(*b*) be entering the First Year of any course in the Faculty of Applied Science and Engineering.

Application must be made to the Registrar of the University by May 1 on the regular University Admission Scholarship Application form.

The first award was made in the Session 1962–63.

ROY JARVIS HENRY ADMISSION SCHOLARSHIPS

The estate of the late Roy Jarvis Henry provides three scholarships of the value of $500 each, to be awarded to students who have achieved high standing on the Ontario Secondary School qualifications required for admission, two of which are open to students entering any course in the Faculty and one open to students entering Geological Engineering. In the lack of a suitable candidate in Geological Engineering, all three awards are tenable in any course in the Faculty. Application must be made on the regular admission scholarship application form.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO BURSARY

The Hydro-Electric Power Commission of Ontario has provided a bursary of the value of $500, which may be awarded to a student entering the second year of the courses in Mathematics and Physics or Commerce and Finance in the Faculty of Arts and Science, or any course in the Faculty of Applied Science and Engineering. Application should be made on the regular in-course bursary form not later than December 1.

IBM – THOMAS J. WATSON MEMORIAL BURSARY FUND

International Business Machines Company Limited has made available one or more bursaries of a total annual value of $1,000 to students registered in any year of a full time course in the university who have standing satisfactory to the committee of Award and demonstrate financial need.

Application should be made to the Registrar of the University by October 31.

INTERNATIONAL NICKEL SCHOLARSHIPS

The International Nickel Company of Canada, Limited, annually provides one scholarship to students entering the University of Toronto for studies in Engineering, Geology, Geophysics, Mathematics, Physics or Chemistry with preference being given to Metallurgical Engineering. Awards are renewable for three additional academic years provided satisfactory standing is maintained.

Valued at $1,200 annually, each scholarship provides for tuition and fees, a $300 living allowance, and a grant of up to $500 to the University as a cost-of-education supplement.

To be eligible for consideration the applicant must obtain an average of 75% or over in the Ontario Grade XIII subjects required for admission to his course and demonstrate financial need.

Application must be made to the Registrar of the University by May 1 on the regular scholarship application form.

JENKINS SCHOLARSHIP

The Jenkins Scholarship, presented by Jenkins Bros., Limited, Montreal, first awarded in 1925, has been donated to continue indefinitely.

This Annual Scholarship, of the value of $200, is awarded to the student of the Third Year registered in any course of the Faculty who has the highest aggregate of percentages for the First, Second and Third Years.

JOHNSON'S WAX SCHOLARSHIP

S. C. Johnson and Son Limited, Brantford, Ontario, have established a Scholarship of an annual value of $800 in each of the Second, Third and Fourth Years or a total possible value of $2,400.

The recipient must:

(*a*) be registered in Chemical Engineering in the years in which the Scholarship is awarded and held;

(*b*) in the opinion of the Council be the most promising and deserving member of the class, obtaining Honours in the final examinations of the First Year;

(*c*) in his Second and Third Years, maintain academic standing satisfactory to the Council, not necessarily Honours, for the continued enjoyment of the Scholarship. In its discretion the Council may recommend the award of any portion of the Scholarship, lost by the original recipient by failure to maintain satisfactory academic standing, to another student of the year(s) in which the Scholarship would otherwise have been enjoyed.

The first award was made on the results of the annual examinations written in April 1954. It is not tenable with any other Scholarship.

KIMBERLY-CLARK CORPORATION OF CANADA LIMITED SCHOLARSHIPS

Kimberly-Clark Corporation of Canada Limited has presented two scholarships of a value of $500 each and each scholarship is accompanied by a grant of $100 to the general funds of the University. One scholarship is awarded to an outstanding student of the First Year and one to an outstanding student of the Second Year as indicated by the examination results of their respective years. Students in all courses of the First and Second Years are eligible.

The first awards were made on the results of the annual examinations for 1957–58.

THE LEONARD FOUNDATION SCHOLARSHIPS

Leonard Foundation Scholarships are awarded each year to selected students in Universities and Colleges across Canada, including the University of Toronto. The Trust Deed states: "Preference in the selection of students for scholarships shall be given to the sons and daughters respectively of the following: (*a*) clergymen, (*b*) school teachers, (*c*) officers, non-commissioned officers and men, whether active or retired, who have served in Her Majesty's military, naval or air forces, (*d*) graduates

of the Royal Military College of Canada, (*e*) members of the Engineering Institute of Canada, (*f*) members of the Mining and Metallurgical Institute of Canada."

All applicants must be nominated by a member of the General Committee. The latest date for the receiving of applications is March 31, for the following academic year. Further information regarding the procedure to be followed in applying for these scholarships may be obtained by writing to Dr. W. E. Taylor, Honorary Secretary, The Leonard Foundation, c/o Toronto General Trusts Corporation, 253 Bay Street, Toronto.

THE J. EDGAR MC ALLISTER FOUNDATION

Through the generosity of the late J. Edgar McAllister, a graduate of the Faculty in 1891, a fund has been established in the University to be known as the J. Edgar McAllister Foundation, to provide financial aid for students who require it, in Mechanical, Chemical, Electrical and Metallurgy and Materials Science. Inquiries should be made in the Faculty Office.

THE JOHN WOLFE MC COLL MEMORIAL AWARDS

These six awards, two of which are open to students in the Faculty of Applied Science and Engineering, are the gift of the estate of the late John Wolfe McColl. The awards have a minimum value of $250 and a maximum of $750. Applicants must have obtained First Class Honours at the final examinations of the preceding year, whether Ontario Grade XIII or at the University of Toronto, demonstrate financial need and be enrolled or undertake to enrol in either Engineering Science or Chemical Engineering. Students seeking first admission to the University must submit applications for an award to the Registrar of the University on or before May 1. Students in the University must submit applications for an award to the Registrar of the University on or before October 15.

THE J. A. D. MC CURDY PRIZE

The J. A. D. McCurdy Prize of a value of $75 was established by the trustees of a fund created by the members of the Number 3 Squadron, University Air Training Corps (1941–44) in honour of John Alexander Douglas McCurdy, a graduate of the School of Practical Science, who "made the first flight in Canada on February 23, 1909, with a heavier-than-air machine."

It is awarded annually to the student registered in Third Year, Aeronautics Option, in Engineering Science, who, taking honours, ranks highest in annual examinations of the Third Year in the subjects related to Aerodynamics.

The first award was made on the results of the examinations of the Session 1953–54.

THE GARNET W. MCKEE-LACHLAN GILCHRIST SCHOLARSHIP IN ENGINEERING SCIENCE

Mrs. Garnet W. McKee and Professor Lachlan Gilchrist each contributed $1,000 to provide for a Scholarship in the First Year of the Course in Engineering Science. The value of the Scholarship is the annual income from the capital fund and is awarded to the student who ranks first in honours at the annual examinations of the First Year in the Course in Engineering Science. If for any reason that student is ineligible to hold the Scholarship, it will be awarded by reversion to the student ranking second in honours in the Course. In order to receive payment the winner must register in the Second Year of the Course in Engineering Science. The Scholarship was awarded for the first time on the results of the annual examinations of 1947.

THE GARNET W. MC KEE-LACHLAN GILCHRIST GEOPHYSICS SCHOLARSHIPS

Financial assistance was received by Professor Lachlan Gilchrist of the Department of Physics, University of Toronto, from certain organizations and individuals to help him in the prosecution of his research work in Geophysics. With the consent of the contributors, the unexpended balance of these gifts was transferred by Professor Gilchrist to the Board of Governors of the University to be used as an endowment for scholarships, two of which were established in the Faculty of Applied Science and Engineering. To this fund have been added additional amounts received from the estate of the late Garnet W. McKee and from the Hollinger Consolidated Gold Mines Ltd. They are awarded by the Senate, on the recommendation of the Council of the Faculty of Applied Science and Engineering. The first awards were made on the results of the Annual Examinations of 1941.

The First Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $200 is awarded to the student in the Second Year in the Course of Engineering Science who obtains the highest aggregate standing at the examinations of the First and Second Years in the Course, provided always that the student obtains honour standing at the examinations of the Second Year.

The Second Garnet W. McKee-Lachlan Gilchrist Geophysics Scholarship. This scholarship, of the annual value of $165 is awarded to the student in the Second Year in the Course of Engineering Science who, of those students who elect to proceed in the Third Year in the Geophysics Option of the Course, obtains the highest aggregate standing at the examinations of the First and Second Years, provided always that the student obtains honour standing at the examinations of the Second Year, and excluding always the student to whom the First Lachlan Gilchrist Geophysics Scholarship has been awarded.

If in any year there is no student who has fulfilled the condition as laid down for the Second Lachlan Gilchrist Geophysics Scholarship, it shall be awarded to the student in the Second Year in the Course in Engineering Science who obtains the second highest aggregate standing at the examinations of the First and Second Years of that Course, provided always that such student obtains honour standing in the examinations of the Second Year.

LACHLAN DALES MC KELLAR ADMISSION SCHOLARSHIPS

Provided by a bequest of the late Leona D. McKellar, two scholarships of the value of $500 each, are offered to students who have achieved high standing on the Ontario Secondary School qualifications required for admission to the Faculty. Application must be made on the regular admission scholarship application form.

THE ALEXANDER MAC LEAN SCHOLARSHIP

This scholarship was established by graduates of the University of Toronto and other friends in honour of Professor Alexander MacLean, B.A. (1908) who retired in 1954. The scholarship, of the value of $250, is awarded to a student in the Third Year of Geological Sciences, Faculty of Arts, or in the Third Year of Geological Engineering, Faculty of Applied Science and Engineering, who, obtaining not less than 75% in the work of the year, obtains the highest standing in the geological subjects common to the two courses.

The first award was made in 1955.

MAC LENNAN-MAC LEOD MEMORIAL PRIZE

The Graduating Class of 1910 has donated an annual prize, known as "The MacLennan-MacLeod Memorial Prize", in memory of their first Class President, George MacLennan, who was killed in action in France in 1917, and of Doug. MacLeod, their first Secretary, who died in France in 1916 from wounds received in action.

The prize, of the value of $25, is awarded to the First Year student in the Faculty of Applied Science and Engineering who ranks highest in Calculus among those who obtain standing without condition at the annual written examinations; or, in the event of more than one student obtaining equally high rank in Calculus, the award is made to the one of these who also has the highest standing in some other subject common to the competitors, such as Analytical Geometry, such subject to be determined by the Council of the Faculty.

An award will not be made in any year in which, in the opinion of the Council, no student obtains a sufficiently high standing in Calculus to merit the award. If in any year no award is made, a second award will be available in subsequent year.

CHARLES GORDON MANNING PRIZE

The Charles Gordon Manning Prize was established by a bequest under the Will of the late Jennie Manning in the amount of $500, the annual income from which is to be used to buy books for the winner of the Prize.

The recipient must be enrolled in the Second Year of a course offered by the Faculty of Applied Science and Engineering and, in the opinion of the Council, rank second to the student awarded the Harvey Aggett Memorial Scholarship in the considerations specified for the award of that Scholarship, namely, obtaining honours in

his final examinations and being one of the first three in his year by his standing at those examinations relative to the pass requirements in his Department and being "adjudged highest of the three in general student activities and service in the University during his period of attendance."

The first award was made on the results of the Annual Examinations of 1954.

MARSLAND ENGINEERING LIMITED SCHOLARSHIP

The Marsland Engineering Limited Scholarship, the gift of Marsland Engineering Limited, has a value of $250. It is awarded to the student who, having been granted a Dominion-Provincial Student Aid Bursary in his First Year, is registered in Mechanical or Electrical Engineering and obtains the highest average percentage of marks, with honours, at the annual examination of the First, Second or Third Years in the session in which the award is made.

The first award was made at the annual examinations of 1954.

MASSEY-FERGUSON LIMITED SCHOLARSHIPS

Massey-Ferguson Limited has established two scholarships each of an annual value of $250, to be awarded on the recommendation of the Council of the Faculty of Applied Science and Engineering to students registered in the Fourth Year of the Courses in Mechanical Engineering or Industrial Engineering. In making the award academic achievement, financial need, extra-curricular activities and such other factors as may be deemed appropriate will be taken into consideration.

Application should be made to the Secretary of the Faculty not later than October 15.

JAMES L. MORRIS MEMORIAL PRIZE

The James L. Morris Memorial Prize is the gift of Mrs. J. H. Craig and Mr. J. R. Morris, K.C., in memory of their father, James L. Morris, C.E., O.L.S., D.Eng., the first graduate of the School of Practical Science, who died in 1946 after a distinguished career. Graduating in Civil Engineering in 1881 as the sole member of his class, Dr. Morris engaged in railway work for some time, first as an engineer and then as a contractor. For 43 years he conducted a successful civil engineering practice in Pembroke, Ontario, involving important undertakings in the field of municipal, power and bridge work.

This Prize, of the value of the annual income from $3,000, is awarded annually to the student in the Second Year of the Course in Civil Engineering who obtains the highest aggregate percentage at the annual examinations of the First and Second Years of the course, provided always that the student obtains honour standing at the Examinations of the Second Year.

OTTO HOLDEN SCHOLARSHIP

Otto Holden, B.A.Sc., C.E., D.Eng., was a distinguished hydraulic engineer of international reputation. He served Ontario Hydro for 47 years and retired as Chief Engineer in 1960, having been involved in almost all of the major hydro-electric developments in Ontario. On his death Mr. Holden left a sum of money which was later augmented by his widow, the late Florence Holden, to establish a scholarship in the Faculty of Applied Science and Engineering. This scholarship, which has a value of approximately $750 is awarded to the student who, completing the Fourth Year in Civil Engineering or Mechanical Engineering with Honours, obtains the highest aggregate marks in hydraulic engineering subjects in the Third and Fourth Years of the course. The first award was made in the session 1967/68.

THE ONTARIO HOCKEY ASSOCIATION WAR MEMORIAL SCHOLARSHIP

The Ontario Hockey Association War Memorial Scholarship, the gift of the Ontario Hockey Association, is to be awarded annually at the Grade XIII examination to an applicant whose father served overseas with the Canadian Forces in World War I.

The value of this scholarship is $100 in cash, with an allowance of the same amount on the tuition fee for each session.

In determining the award of the scholarship, the academic qualifications of the candidate shall be first taken into account, provided always that no candidate shall be eligible for an award who has not met all the conditions required by the University of candidates for admission scholarships generally; but, *cæteris paribus,* the award shall be made to a student who is in proved need of assistance.

The award shall be made by the Senate of the University upon the report of a committee to be appointed by the Senate, upon which committee there shall be always one member of the Staff of the University who shall be deemed to be representative of the Association.

Application should be made to the Registrar of the University on the regular scholarship application form not later than May 1.

ORENDA LIMITED SCHOLARSHIPS

Orenda Limited has donated three scholarships each of a value of $500, awarded annually to students completing the First, Second and Third Years respectively in courses other than Geological Engineering. These scholarships are awarded to students with high academic standing and in cases of close competition, preference will be given to the student who indicates that he possesses initiative and leadership qualities and that he will be a credit to his profession after graduation.

This award may be held with other awards provided that the monetary value of the other awards does not exceed $100. The first award was made in the Session 1955–56.

PAULIN MEMORIAL SCHOLARSHIP

The Paulin Memorial Scholarship, provided through the generosity of the late Mr. Fred W. Paulin, a graduate of this Faculty in 1907, was established in memory of his brother, John Cameron Paulin, a student of this Faculty, who was fatally injured in 1906 during a football practice. The scholarship, which has the value of the income from a capital fund of $10,000, approximately $475 annually, is awarded to a student who obtains high standing in the work of the first year in the Faculty of Applied Science and Engineering.

PROCTER AND GAMBLE BURSARY PLAN

Procter and Gamble Bursaries, the gift of the Procter and Gamble Company of Canada, are awarded annually to students in all years. Applicants must have at least Second Class Honours or better in the final examinations of the preceding year and demonstrate financial need. Applications must be submitted to the Registrar of the University on or before December 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO ADMISSION SCHOLARSHIP

The Ontario Professional Engineers Foundation for Education provides an admission scholarship of the value of $500. It is awarded to the candidate who obtains the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to the Council that his attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Application must be made to the Registrar before May 1.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO SCHOLARSHIPS

The Ontario Professional Engineers Foundation for Education offers scholarships of a value of $250 in each of the First, Second and Third Years in the Faculty of Applied Science and Engineering in any course, to the students who, taking Honours, obtain the highest standing in the work of their respective years.

These scholarships will not be awarded to students who hold other scholarships.

PROFESSIONAL ENGINEERS GOLD MEDAL

The Association of Professional Engineers of the Province of Ontario has established in the Faculty of Applied Science and Engineering an award in the form of a gold medal accompanied by a gift of technical books of an approximate value of $50. The award will be made to the student of the final undergraduate year in any course who, taking honours, obtains the highest weighted average percentage in the practical work and written examinations of the year.

RANSOM SCHOLARSHIP IN CHEMICAL ENGINEERING

The Ransom Scholarship in Chemical Engineering is presented by A. C. Ransom, Esq., of Toronto, for the purpose of encouraging and giving financial assistance to students who choose the field of Chemical Engineering. This donation, consisting of $5,000, provides for a perpetual scholarship of an annual amount such as will be derived from the income of this sum. The first award was made on the results of the annual examinations of 1938.

The scholarship will be awarded annually to the student registered in the Course in Chemical Engineering who obtains the highest aggregate percentage of marks in the examinations of the First Year. The scholarship will be paid to the winner only if he proceeds to take his Second Year in the Course in Chemical Engineering in the University of Toronto.

J. E. REID MEMORIAL PRIZE

This prize, established in 1967 in memory of the late Professor J. E. Reid, is awarded to the student in the Fourth Year of the course in Electrical Engineering who, graduating with honours, achieves the highest aggregate marks in the Fourth Year examinations in the subjects pertaining to electronic communication.

THE RHODES SCHOLARSHIPS

The Rhodes Trustees offer for award in the Province of Ontario two out of ten of the Rhodes Scholarships for Canadians, each of the value of £1,000 and tenable at Oxford University for a period of two years; in certain cases, a third year may be authorized.

Each candidate must be a British subject with at least five years domicile in Canada and unmarried; he must have passed his nineteenth but not twenty-fifth birthday on October 1 of the year *for* which he is elected; he must have completed the first year of his course at a Canadian university at the time of application.

A candidate may apply either for the province in which he has his private home or residence, or for the province in which he has taken his university course.

In that section of the will in which he defined the general type of scholar he desired, Mr. Rhodes mentioned four groups of qualities, the first two of which he considered most important.

(1) Literary and scholastic attainments;

(2) Qualities of manhood, truth, courage, devotion to duty, sympathy, kindliness, unselfishness, and fellowship;

The scholarship will be awarded annually to the student registered in the Course in

(3) Exhibition of moral force of character and of instincts to lead and to take an interest in his fellows;

(4) Physical vigour, as shown by fondness for and success in outdoor sports.

Some definite quality of distinction, whether in intellect, character or personality, or in any combination of these, is the most important requirement. Financial need does not receive special consideration.

Forms of application and full information regarding these scholarships may be obtained from the Registrar, University of Toronto, or from the secretary of the Ontario Selection Committee, Alistair W. Gillespie, Esq., Suite 1602, 50 King St. W., Toronto. Selection is made in December for the following year and all applications must reach the provincial secretary before November 15 annually.

R.C.E. MEMORIAL SCHOLARSHIP

The Memorial Fund Committee of the Royal Canadian Engineers has established the R.C.E. Memorial Scholarship of a value of $125, open to students who have successfully completed their second to last year in the Faculty of Applied Science and Engineering or the School of Architecture.

A candidate must be

(*a*) a member in good standing of the Canadian Officers Training Corps and have successfully completed one summer season's training, or

(*b*) an ex-member of the Canadian Officers Training Corps who has successfully completed two years of C.O.T.C. Training and has transferred to the Canadian Army (Militia) or to the Canadian Army (Supplemental Reserve), or

(*c*) a member of the Canadian Army (Regular) attending University under the Regular Officers Training Plan.

Selection is made on the basis of academic standing and of qualities of leadership.

Application forms may be obtained from the office of the Registrar.

REGULAR OFFICER TRAINING PLAN

Tenable in approved degree courses, this plan is available to Canadian citizens who undertake to serve in the armed forces for at least four years after graduation. Accepted candidates will receive tuition, a book allowance of $125 and a living allowance of $187 per month during the academic session.

Application should be made to the Canadian Forces Recruiting Centre, 25 St. Clair Avenue West, Toronto 7.

HELEN E. ROGERS ADMISSION SCHOLARSHIPS

Admission scholarships have been established from a bequest from the estate of Helen E. Rogers open to students entering any degree course in the University. Preference is given to applicants from outside Ontario but failing such candidates awards may

be made to qualified Ontario students. Recipients must have a standing satisfactory to the Committee of Award on first admission and may continue to enjoy the scholarship in the upper years provided they maintain first class standing. The value in each year is a minimum of $200 and a maximum of $1,500 dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University by May 1 on the regular admission scholarship application form.

DON SALT MEMORIAL SCHOLARSHIPS

In memory of Donald John Salt, a graduate of the Faculty of Applied Science and Engineering and a practising geophysicist, the Canadian Exploration Geophysical Society has provided two scholarships of the value of $500 which are open to students in the Third and Fourth Years of certain courses in the Faculty of Arts and Science, and in Geological Engineering and the Geophysics option of Engineering Science in the Faculty of Applied Science and Engineering.

The award is made on evidence of the interest and ability of the applicant in relation to the field of mining geophysics.

Application should be made either to the Chairman of the Department of Physics or the Chairman of the Department of Geology by March 1 in the calendar year in which the award is to be made.

FREDERICK W. SCHUMACHER SCHOLARSHIP

The Frederick W. Schumacher Scholarship has been awarded in the Faculty of Applied Science and Engineering and in the Faculty of Arts under a bequest of the late Frederick W. Schumacher. It has a value of the income from the fund. The scholar must (*a*) be enrolled in the Second, Third or Fourth years in Geological Engineering in the Faculty of Applied Science and Engineering or in Physics and Geology or Geological Sciences in the Faculty of Arts and (*b*) must have high academic standing.

Applications must be submitted to the University Registrar not later than October 15.

"SECOND MILE ENGINEER" AWARD

The Class of 3T5, convinced that a successful engineer must not only be professionally competent but also constantly aware of his responsibilities to humanity, and inspired by an address of President William E. Wickenden of the Case School of Applied Science, Cleveland, called "The Second Mile," which was based on the text from the Sermon on the Mount, "whosoever shall compel thee to go one mile, go with him twain" has established the "Second Mile Engineer" award. It is the desire of the donors to encourage undergraduates to participate fully in extra-curricular activities and to recognize the true importance of the more liberal subjects of the

curriculum with the ultimate objective, on entering the profession, of becoming worthy Second Mile Engineers. The award comprises a grant of $200, a suitably inscribed presentation piece and an illuminated scroll, and is presented to a student in his final year.

An eligible group is chosen from those who have taken a prominent part in the affairs of the Faculty, either as office holders or in athletics. In making the award consideration is given to academic standing, with special emphasis on the candidate's attainments in the cultural and humanistic-social studies. The subjects which are stressed are English of the First Year; Economics of the Second Year; and Political Science and Modern World History of the Third Year.

Particulars are furnished each session by the Class of 1935.

THE SIMPSONS-SEARS LIMITED (NORTHERN ONTARIO) SCHOLARSHIPS

These scholarships, the gift of Simpsons-Sears Limited, are open only to students of the Copper Cliff High School, The Sudbury High and Technical Schools, the Sturgeon Falls High School, the North Bay Collegiate Institute and Vocational School, the Kapuskasing High School and all the Secondary Schools along the Ontario Northland Railway. A scholarship of the value of $100 is available for each of the schools mentioned and an additional sum of $50 will be given to the student who obtains the highest percentage of the nine papers of Grade XIII selected in accordance with the regulations.

No scholarship will be awarded unless the candidate is in actual attendance in one of the colleges or faculties of the University and maintains a uniformly high standard to the satisfaction of the donors of the scholarships.

Application for these scholarships must be sent not later than May 15, to the Principal of the North Bay Collegiate Institute and Vocational School, from whom further information may be obtained regarding conditions of award.

WALLACE AWARD
SOCIETY OF AUTOMOTIVE ENGINEERS PRIZE

In memory of William Wallace, Professor of Mechanical Engineering, University of Toronto, the Ontario Society of Automotive Engineers offers an annual prize of the value of $100 to a student of the Fourth Year in any course whose thesis on a topic related to Automotive Engineering is considered by the Head of the Department of Mechanical Engineering to be of suitable quality and the most satisfactory.

SOCIETY OF CHEMICAL INDUSTRY MERIT AWARD

The Society of Chemical Industry Merit Award is made annually by the Society to the student in Fourth Year in the Department of Chemical Engineering who obtains the highest weighted average of marks in the results of the annual examinations for the year. The award is a gold key.

THE MURRAY F. SOUTHCOTE SCHOLARSHIP

Established by friends of the late Murray F. Southcote, a graduate of this Faculty (Aeronautical Engineering, 1950) this scholarship, which has a value of $100, is awarded in recognition of high standing at the Annual Examinations of the Third Year, in any course in the Faculty.

The first award was made in the Session 1964–65.

SPRUCE FALLS POWER AND PAPER COMPANY LIMITED SCHOLARSHIPS

The Spruce Falls Power and Paper Company Limited has established four Scholarships of a value of $400 each, two in the Second Year and two in the Third Year. They are awarded on the results of the Annual Examinations of the Second and Third Years to the students who obtain honour standing at the examinations of their respective years and are open to students in all courses in the Faculty. The first awards were made on the results of the examinations of 1951.

Each scholarship carries a grant of $150 to the University General Funds.

WALTER STERLING ADMISSION SCHOLARSHIPS

Established in memory of Walter Sterling, these scholarships are open to students entering any first degree course at the University of Toronto. Recipients must obtain First Class Honours standing on the nine Ontario Grade XIII papers required for admission, and may continue to enjoy the scholarships in each year of their course providing they maintain Honour standing. The value of the scholarship is from $200 to $1,500 annually, dependent on financial need. The number of awards made each year is determined by the annual income available.

Application should be made to the Registrar of the University on the regular scholarship application form. The statement of financial need should be completed if an award greater than $200 is desired.

THE WILLIAM STORRIE MEMORIAL SCHOLARSHIPS IN CIVIL ENGINEERING

Three Scholarships have been established by Mrs. William Storrie in memory of her husband, the late William Storrie, a Consulting Engineer on many municipal projects in Canada and for several years a special lecturer in the Faculty of Applied Science and Engineering, for students in Civil Engineering, as follows:

(*a*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Second Year in Civil Engineering.

(*b*) Of a value of $100 to a student who obtains high standing in the annual examinations of the Third Year in Civil Engineering.

(*c*) Of a value of $200 to the student who obtains the highest standing in the annual examinations of the Fourth Year in the Municipal and Sanitary Option of the course in Civil Engineering.

In all cases the candidates shall have demonstrated qualities of integrity and shown promise of leadership in their profession.

The first awards were made for the Session 1956–57.

EDITH TYRRELL MEMORIAL BURSARY

The Women's Association of the Mining Industry of Canada has presented this Bursary, having the value of $600, annually, commencing in 1939, and named in memory of their founder and first president, Mrs. Edith Tyrrell. A medal donated by Dr. Tyrrell accompanies this Bursary. The Bursary is awarded to a student entering the Third or Fourth Year in the Course of Metallurgy and Materials Science, or Geological Engineering; it may be awarded two years in succession to the same student, but will usually be awarded at the beginning of the Third Year. The award will be made by a special committee appointed by the Association on the following basis:

(*a*) In addition to mental capacity, the student must show leadership ability and give promise, through his activities, of becoming a worthwhile influence in the affairs of the profession and the community.

(*b*) While attention is given to scholastic ability, as evidenced by his academic standing, it is not the governing factor. He must, however, stand in the top quarter of his class.

(*c*) Special consideration is given to financial need.

Application must be made to the Secretary of the Faculty within one month of the opening of the academic year.

S. UBUKATA FUND

The S. Ubukata Fund for Japanese students was established to assist students from Japan proper to pursue a course of study at the University of Toronto. The fund provides grants of varying values on the basis of the information submitted by the applicants who:

(*a*) must be Japanese students from Japan proper;

(*b*) must register in the University of Toronto devoting full time to their studies;

(*c*) are able to satisfy admission requirements regarding English facility;

(*d*) are not holding other financial aid.

UNIVERSITY OF TORONTO ALUMNI ASSOCIATION WAR MEMORIAL SCHOLARSHIPS

Six scholarships are awarded annually by the University of Toronto Alumni Association to students entering first degree courses at the University of Toronto. The scholarships have a value of $500 annually, and are tenable for two years, providing satisfactory academic standing is maintained. They are awarded for general proficiency in Grade XIII, and in addition to academic performance the committee of award will take into consideration the candidate's relationship to active service in the Armed Forces of Canada, need of financial assistance, participation in extra-curricular

activities and such other qualifications as may commend themselves to the committee. One scholarship will be available to a student whose home is not in the Province of Ontario.

Students resident in Ontario may apply on the general admission scholarship form which must be submitted to the Registrar of the University not later than May 1. Evidence of relationship to active service in the Armed Forces of Canada should be attached. Students resident outside Ontario may obtain the necessary forms from the Awards Department, Office of the Registrar, University of Toronto.

THE U.T.S. ENGINEERING SCHOLARSHIP

The U.T.S. Engineering Scholarship, the gift of R. A. Bryce, Esq., of the value of $250. The scholarship will be awarded by a committee of the Staff of the University of Toronto Schools to a student of the Schools who has completed the requirements for admission to and enrols in the Faculty of Applied Science and Engineering.

WALLBERG ADMISSION SCHOLARSHIPS

Two admission scholarships, each of a value of $500 are awarded annually from the income from the Wallberg Bequest on the recommendation of the Council of the Faculty to the two candidates who obtain the highest average percentage in the subjects of Grade XIII prescribed for admission to the Faculty of Applied Science and Engineering. In order to qualify for the scholarship a candidate must at one Scholarship examination obtain an average of at least 75% in the subjects of Grade XIII prescribed for admission to the Faculty and must register in the Faculty of Applied Science and Engineering. The scholarship will not be awarded to a student who has spent more than one year in Grade XIII or more than five years in a Secondary School or its equivalent unless he can show evidence satisfactory to Council that this attendance has been extended beyond the period specified for reasons beyond his control. This scholarship is not tenable with any other Admission scholarship.

Applications must be submitted to the Registrar on the prescribed form by May 1.

WALLBERG UNDERGRADUATE SCHOLARSHIPS

These scholarships, four in number, of the value of $500 each, derived from the Wallberg Bequest, are awarded annually; two to students ranking first and second respectively at the annual examinations of the First Year; one to the student ranking first at the annual examinations of the Second Year; and one to the student ranking first at the annual examinations of the Third Year.

Any holder of one of these scholarships may not hold other awards listed in the index with an asterisk. The awards were first made on the result of the annual examination of 1947.

W. S. WILSON MEDALS

These medals have been provided in recognition of the service to the Faculty of Applied Science and Engineering of its former Assistant Dean and Secretary, William Stewart Wilson.

A medal will be awarded to the student in each graduating course, who, attaining Honours, achieves the highest standing in the final year of his course.

The first awards were made in the Session 1962–63.

WILLIAM R. WORTHINGTON MEMORIAL SCHOLARSHIP

The William R. Worthington Memorial Scholarship, the gift of Miss Ida R. Worthington, in memory of her brother, William R. Worthington, DIP.(1904), B.A.SC.(1905), of the value of the income from a fund is awarded annually to the student of the Second Year in the course in Civil Engineering who ranks highest at the annual examinations of that year.

The first award was made at the examinations for the Session 1954–55.

LOAN FUNDS

From the loan funds mentioned below, small loans can be made to students who are in urgent need of assistance. The funds are not large and the loans must accordingly be restricted, both in amount and number, and principally to students in the Third and Fourth Years.

Enquiries for loans from any of the following funds should be made at the office of the Secretary of the Faculty.

Engineering Society Loan Fund
Elizabeth Speller Memorial Fund
James W. Crocker Memorial Fund
Harry F. Bennett Educational Fund
S.A.E. – Canadian Section Loan Fund
Class of 2T7 (SPS) Memorial Loan Fund
Avro Aircraft Limited Engineering Loan Fund
The William Storrie Memorial Fund
3T6 Engineers Loan Association
4T0 Engineering Loan Fund
Women's Association of the Mining Industry in Canada Loan Fund
The Devonshire Loan Fund
Class of '09 Trust Fund
University of Toronto Alumni Loan Fund

CLASS OF 1936 LOAN ASSOCIATION

Members of the Class of 1936 have made arrangements to assist students in obtaining loans through regular banking facilities. Information may be obtained from the Secretary of the Faculty.

ENGINEERING SOCIETY LOAN FUND

In 1932 the Engineering Society repaid to the Board of Governors a series of annual grants which, over a period of years, had been made to the Society for special purposes. The Board of Governors, appreciating this action, set aside this sum, to be known as the Engineering Society Loan Fund, to provide loans to students of the Faculty of Applied Science and Engineering. The administration of the fund is carried out by a Committee appointed by the Board. The fund is not large, and only small loans can be made to relatively few students. Further inquiries should be made at the office of the Secretary of the Faculty.

ELIZABETH SPELLER MEMORIAL FUND

Through the generosity of Dr. F. N. Speller, of the Class of 1893, the "Elizabeth Speller Memorial Fund" has been established to provide loans for worthy students of the Third and Fourth Years of this Faculty. Applications for loans from this Fund should be made to the Secretary of the Faculty.

JAMES W. CROCKER MEMORIAL LOAN FUND

This fund was established by Mrs. William Crocker in memory of her son, James W. Crocker, a graduate in Mining Engineering in 1938, who was killed in an accident in a mine in the same year.

HARRY F. BENNETT EDUCATIONAL FUND

This fund was established by subscription from members of The Engineering Institute of Canada in memory of the late Harry F. Bennett, M.E.I.C., who for six years prior to his death in 1946 was chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, and who accomplished so much in this field by untiring efforts.

One purpose of the fund is to make loans to deserving students who need financial assistance to enable them to study engineering sciences at university level, and who have proved themselves by successfully completing their first year in engineering or the equivalent.

Loans will be made largely on the basis of character and to men who seem likely to develop the high professional standards which are essential to leadership in engineering science. A student who has been aided by this fund should feel that high obligations are placed on him; obligations to the subscribers, to the trustees, and to those coming after him who in turn can receive help as his loan is repaid.

Application forms may be obtained at the Faculty Office. The regulations are simple and the application of any worthwhile student will be given immediate and careful attention.

SOCIETY OF AUTOMOTIVE ENGINEERS – CANADIAN SECTION LOAN FUND

The Society of Automotive Engineers – Canadian Section has established a loan fund of $1,200 in the Faculty of Applied Science and Engineering. Preference is given to students in good scholastic standing and engaged in studies relative to the automotive and aircraft industries, and to students in fourth, third and second years in that order. Particulars may be obtained from the Secretary of the Faculty.

AVRO AIRCRAFT LIMITED ENGINEERING LOAN FUND

Avro Aircraft Limited has established a Loan Fund of $3,000 to provide loans to engineering students requiring financial assistance. Application should be made to the Secretary of the Faculty.

THE WILLIAM STORRIE MEMORIAL FUND

The William Storrie Memorial Fund has been established by Mrs. William Storrie to provide loans to undergraduates in the course in Civil Engineering. Application should be made to the Secretary of the Faculty.

THE DEVONSHIRE LOAN FUND

This Fund has been established by Graduates and friends of Devonshire House to assist students in the Residence. Application should be made to the Office of the Dean of Devonshire House.

CLASS OF '09 TRUST FUND

The Class of '09 on the 50th Anniversary of their graduation made a sum of money available in the Faculty for financial aid to undergraduates, with preference to Second Year students. Inquiry should be made to the Secretary of the Faculty.

THE UNIVERSITY OF TORONTO ALUMNI LOAN FUND

This fund comes from subscriptions received originally in 1919 and in succeeding years from graduates of the University and is administered by the University of Toronto Alumni Association.

Loans are available to undergraduate and graduate students enrolled in a full time course at the University, in second and subsequent years.

Particulars may be obtained from The University of Toronto Alumni Association, Alumni House, 18 Willcocks Street, Toronto, or from the Secretary of the Faculty or School.

IX Discipline

A SUMMARY OF THE REGULATIONS OF THE CAPUT CONCERNING STUDENT DISCIPLINE

1. Subject to the general regulations of the Caput of the University regarding jurisdiction in matters of discipline the Council of University College, the governing bodies of the Federated Universities and Affiliated Colleges, and the Councils of the Faculties, Schools, and Institutes have disciplinary jurisdiction over the conduct of all students registered in these Divisions of the University in all matters of local or internal concern to these Divisions. Jurisdiction over the conduct of students while in residence regardless of the Division of the University in which they are registered is vested in the body administering the residence.

2. Jurisdiction concerning conduct likely to affect the interests of the University as a whole is vested in the Caput.

3. The Students' Administrative Council will be supported in the proper performance of all its obligations and duties as provided in its Constitution.

4. Where the appropriate body exercising disciplinary jurisdiction has found that a student of the University has engaged in conduct prejudicial to the interests of the University, the Caput may, in its discretion, suspend or expel such student from the academic privileges of the University. Every decision of the Caput involving the expulsion of a student from the University requires confirmation of the Board of Governors.

5. Any student who interferes with the personal liberty of another or who subjects another student to indignity or personal violence may be considered by the Caput or any other body exercising disciplinary jurisdiction in the University to have committed a breach of discipline.

6. Initiation ceremonies involving physical violence, personal indignity, interference with personal liberty, or destruction of property, may be deemed a breach of discipline by the Caput or any other body exercising disciplinary jurisdiction in the University.

7. Without limiting the disciplinary powers vested in the respective bodies exercising disciplinary jurisdiction as set forth in sections 1–7, the following are cited as illustrations of conduct which, in the past, has been considered a breach of discipline prejudicial to the interests of the University:

(i) The organising of a parade on the streets of the city or the taking part in such a parade without permission of the authorities.

(ii) The destruction or defacing of University property, raids on Residences or other University buildings, and the breaking into University buildings.

(iii) Rowdy and other forms of behaviour, either on or off the Campus, of such an objectionable nature as to bring the University into public disrepute.

8. Student Clubs and Associations

(a) The constitution of every society or association of students in the University and all amendments to such constitutions require to be approved by the relevant University authorities. The giving of approval, and the responsibility for the programmes of student societies and associations, shall rest as follows:

(i) With the authorities of the College, Faculty or School concerned where the membership of the student society or association is drawn from a single College, Faculty or School.

(ii) With the Board of Stewards of Hart House, where the student society or association is a Committee of Hart House and is controlled by the Board of Stewards of Hart House.

(iii) With the Caput, in the case of all other student societies and associations.

(b) No approval will be given by any of the authorities listed in (a) above to the constitution of any society or association of students if that constitution permits:

(i) Membership in the society or association to persons who are not students of the University, unless in the case of the societies listed in (a) (ii) above, where membership is open also to graduates of the University and members of the Faculty of the University.

(ii) Any action of discrimination based upon race, religion, or colour.

9. The name of the University is not to be used in connection with a publication of any kind without permission of the Caput.

OF THE FACULTY OF APPLIED SCIENCE AND ENGINEERING

E. A. Allcut, M.SC.(BIRM.), M.E., F.R.AE.S.
Professor Emeritus of Mechanical Engineering

W. B. Dunbar, B.A.SC.,
Professor Emeritus of Engineering Drawing

C. E. Helwig, M.A.SC.,
Professor Emeritus of Civil Engineering

K. B. Jackson, B.A.SC., D.SC.(WATERLOO),
Professor Emeritus of Applied Physics

O. J. Marshall, B.A.SC., C.E., O.L.S.
Professor Emeritus of Civil Engineering

W. G. McIntosh, B.A.SC.,
Professor Emeritus of Mechanical Engineering

R. R. McLaughlin, M.A.SC., M.A., PH.D., D.SC.,
Professor Emeritus of Chemical Engineering

J. W. Melson, B.A.SC.,
Professor Emeritus of Surveying and Geodesy

C. F. Morrison, B.E.(SASK.), M.SC.(MCG.),
Professor Emeritus of Civil Engineering

L. M. Pidgeon, M.B.E., B.SC.(OXON.), PH.D.(MCG.), F.R.S.C.
Professor Emeritus of Metallurgical Engineering

E. A. Smith, M.A.(MCM.),
Professor Emeritus of Chemical Engineering

V. G. Smith, B.A.SC.,
Professor Emeritus of Electrical Engineering

G. F. Tracy, B.A.SC., S.M.(M.I.T.),
Professor Emeritus of Electrical Engineering

A. Wardell, B.A.SC.,
Professor Emeritus of Engineering Drawing

W. J. T. Wright, M.B.E., B.A.SC., B.A.,
Professor Emeritus of Engineering Drawing

1968–1969

THE UNIVERSITY

President: C. T. Bissell, M.A., PH.D., D. ÈS L., D.LITT., LL.D., F.R.S.C.
Acting President: J. H. Sword, M.A. *(1967–68 Session)*
Vice-Provost and Executive Assistant to the President: D. F. Forster, B.A., A.M.
Assistant to the President: N. S. C. Dickinson, C.D., B.A.

Vice-President and Provost: M. St. A. Woodside, M.A., LL.D.

Vice-President (Health Sciences): J. D. Hamilton, M.D., F.R.C.P.(C.)
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G. de B. Robinson, M.B.E., B.A., PH.D., F.R.S.C.

Chief Librarian: R. H. Blackburn, M.A., B.L.S., M.S., LL.D.

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Vice-President (Administration): F. R. Stone, B.COM., C.A.
Financial Analyst: G. L. Court, D.F.C., M.COM., C.A.
Secretary of the Board of Governors and
Director of Administrative Services: D. S. Claringbold
Director of Physical Plant: F. J. Hastie, B.SC., P.ENG.
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Director of University Health Service: G. E. Wodehouse, M.C., M.D., F.R.C.P.
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Director of International Student Centre: Mrs. K. Riddell, B.A.
Director of the Advisory Bureau: D. J. McCulloch, B.A., M.D., D.PSYCH., F.R.C.P.
Director of Housing Service: Mrs. M. G. Jaffary, B.A.

Director of University Extension: G. H. Boyes, M.A.
Director of University of Toronto Press: M. Jeanneret, B.A., LL.D.
Director of Information: K. S. Edey
Director of Alumni Affairs: J. C. Evans, B.A.
Director of Development: R. J. Albrant
Warden of Hart House: E. A. Wilkinson, B.A.
Director of Athletics and Physical Education – Men: W. A. Stevens, B.S.
Director of Athletics and Physical Education – Women (Acting):
Miss A. Hewett, B.ED., P.E.

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The University of Toronto issues the following calendars and other publications concerning courses of instruction given by the University, any one of which may be had on application to the Office of Admissions of the University, or to the Secretary of the Faculty, School or Institute about which information is sought.

GENERAL INFORMATION:	University of Toronto Handbook
ADMISSION INFORMATION:	Admission Awards
	Admission Circular
APPLIED SCIENCE AND ENGINEERING:	Faculty of Applied Science and Engineering
	Engineering at Toronto – descriptive brochure
	Diploma Course in Operations Research
ARCHITECTURE:	School of Architecture
	Landscape Architecture – descriptive brochure
	Graduate Work in Architecture – descriptive brochure
ARTS AND SCIENCE:	Faculty of Arts and Science
	Courses and Subjects in Arts and Science
	Diploma Course in Computing and Data Processing
BUSINESS:	School of Business – Graduate Programme in Business Administration
CHILD STUDY:	Institute of Child Study
DENTISTRY:	Faculty of Dentistry
	Courses for Graduates in Dentistry
	Dental Hygiene
EDUCATION:	The College of Education
	Graduate Degrees in Education*
EXTENSION:	Degree Courses in Extension
	Certificate Course in Business
	Certificate Course in Public Administration
	Certificate Course in Criminology
	Evening and Afternoon Courses in the Liberal Arts
	Business and Professional Courses
	Correspondence Courses
	Pre-School Education
FOOD SCIENCES:	Faculty of Food Sciences
FORESTRY:	Faculty of Forestry
GRADUATE STUDIES:	School of Graduate Studies
HYGIENE:	School of Hygiene
LAW:	Faculty of Law
LIBRARY SCIENCE:	School of Library Science
MEDICINE:	Faculty of Medicine
	Division of Rehabilitation Medicine
	Division of Postgraduate Medical Education
MUSIC:	Faculty of Music
	The Royal Conservatory of Music
	School of Music Year Book
	General Syllabus
	Pianoforte and Theory Syllabus
NURSING:	School of Nursing
PHARMACY:	Faculty of Pharmacy
PHYSICAL AND HEALTH EDUCATION:	School of Physical and Health Education
SOCIAL WORK:	School of Social Work

*Write to: Ontario Institute for Studies in Education, 102 Bloor Street West, Toronto 181, Ontario.

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